National Défense
Defence nationale

B-GL-323-003/FP-001

ARMY

OPERATIONS IN COLD WEATHER

(ENGLISH)

(Supersedes B-0G-302-002/FP-001 dated 1977-01-14)

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Issued on the authority of the Commander Canadian Army

Canada

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FOREWORD

1. B-GL-323-003/FP-001 *Operations in Cold Weather* is issued on the authority of the Commander Canadian Army by the Directorate of Army Doctrine, LFDTS Kingston, Ontario.

2. This publication is effective upon receipt and supersedes B-0G-302-002/FP-001 *Specific Operations,* Volume 2*, Arctic and Sub-Arctic Operations,* Part 2*, Northern Operations* dated 1977-01-14, which is to be destroyed IAW existing regulations.

3. The French version of this publication is B-GL-323-003/FP-002 *Opérations par temps froid*.

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DWAN email: +DAD Common@LFDTS HQ@Kingston

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Land Forces Doctrine and Training System
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Kingston, ON
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PREFACE

AIM

1. This publication, B-GL-323-003/FP-001 *Operations in Cold Weather*, establishes doctrine for military operations in areas of cold and extreme cold weather conditions. This includes areas of northern Canada, but also any areas with these cold conditions, in either the northern or southern hemisphere, including high-altitude operations, deserts at night, and the vast areas of the Subarctic in North America, Europe and Asia.

SCOPE

2. This publication provides a wide range of material in support of commanders and staff at all levels of command. It reflects the concepts of Canadian doctrinal philosophies and principles. This publication addresses the following:

   a. introduction to areas where extreme cold is routinely encountered;

   b. how to survive in these regions;

   c. how to ensure mobility in these regions; and

   d. how to fight in these regions.

PURPOSE

3. This publication is intended to assist in the planning and conduct of operations in areas of cold and extreme cold anywhere in the world. It provides guidance for all levels of command.

ASSOCIATED PUBLICATIONS

4. This publication should be read in conjunction with B-GG-302-002/FP-001 *Specific Operations,* Volume 2, *Arctic and Sub-Arctic Operations,* Part 1 *Basic Cold Weather Training* and B-GG-302-002/FP-003 *Specific Operations,* Volume 2, *Arctic and Sub-Arctic Operations,* Part 3, *A Soldiers Guide to the Cold.*

ROBERT W. SERVICE (1874–1958)

THE CREMATION OF SAM MCGEE

There are strange things done in the midnight sun
By the men who moil for gold;
The Arctic trails have their secret tales
That would make your blood run cold;
The Northern Lights have seen queer sights,
But the queerest they ever did see
Was that night on the marge of Lake Lebarge
I cremated Sam McGee.

Now Sam McGee was from Tennessee, where the cotton blooms and blows.
Why he left his home in the South to roam ’round the Pole, God only knows.
He was always cold, but the land of gold seemed to hold him like a spell;
Though he’d often say in his homely way that “he’d sooner live in hell.”

On a Christmas Day we were mushing our way over the Dawson trail.
Talk of your cold! through the parka’s fold it stabbed like a driven nail.
If our eyes we’d close, then the lashes froze till sometimes we couldn’t see;
It wasn’t much fun, but the only one to whimper was Sam McGee.

And that very night, as we lay packed tight in our robes beneath the snow,
And the dogs were fed, and the stars o’erhead were dancing heel and toe,
He turned to me, and “Cap,” says he, “I’ll cash in this trip, I guess;
And if I do, I’m asking that you won’t refuse my last request.”

Well, he seemed so low that I couldn’t say no; then he says with a sort of moan:
“It’s the cursèd cold, and it’s got right hold till I’m chilled clean through to the bone.
Yet ’taint being dead—it’s my awful dread of the icy grave that pains;
So I want you to swear that, foul or fair, you’ll cremate my last remains.”

A pal’s last need is a thing to heed, so I swore I would not fail;
And we started on at the streak of dawn; but God! he looked ghastly pale.
He crouched on the sleigh, and he raved all day of his home in Tennessee;
And before nightfall a corpse was all that was left of Sam McGee.

There wasn’t a breath in that land of death, and I hurried, horror-driven,
With a corpse half hid that I couldn’t get rid, because of a promise given;
It was lashed to the sleigh, and it seemed to say: “You may tax your brawn and brains,
But you promised true, and it’s up to you to cremate those last remains.”

Now a promise made is a debt unpaid, and the trail has its own stern code.
In the days to come, though my lips were dumb, in my heart how I cursed that load.
In the long, long night, by the lone firelight, while the huskies, round in a ring,
Howled out their woes to the homeless snows—O God! how I loathed the thing.

And every day that quiet clay seemed to heavy and heavier grow;
And on I went, though the dogs were spent and the grub was getting low;
The trail was bad, and I felt half mad, but I swore I would not give in;
And I'd often sing to the hateful thing, and it hearkened with a grin.

Till I came to the marge of Lake Lebarge, and a derelict there lay;
It was jammed in the ice, but I saw in a trice it was called the "Alice May."
And I looked at it, and I thought a bit, and I looked at my frozen chum;
Then "Here," said I, with a sudden cry, "is my cre-ma-tor-eum."

Some planks I tore from the cabin floor, and I lit the boiler fire;
Some coal I found that was lying around, and I heaped the fuel higher;
The flames just soared, and the furnace roared—such a blaze you seldom see;
And I burrowed a hole in the glowing coal, and I stuffed in Sam McGee.

Then I made a hike, for I didn't like to hear him sizzle so;
And the heavens scowled, and the huskies howled, and the wind began to blow.
It was icy cold, but the hot sweat rolled down my cheeks, and I don't know why;
And the greasy smoke in an inky cloak went streaking down the sky.

I do not know how long in the snow I wrestled with grisly fear;
But the stars came out and they danced about ere again I ventured near;
I was sick with dread, but I bravely said: "I'll just take a peep inside.
I guess he's cooked, and it's time I looked;" ... then the door I opened wide.
And there sat Sam, looking cool and calm, in the heart of the furnace roar;
And he wore a smile you could see a mile, and he said: "Please close that door.
It's fine in here, but I greatly fear you'll let in the cold and storm—
Since I left Plumtree, down in Tennessee, it's the first time I've been warm."

There are strange things done in the midnight sun
By the men who moil for gold;
The Arctic trails have their secret tales
That would make your blood run cold;
The Northern Lights have seen queer sights,
But the queerest they ever did see
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PART 1
COLD WEATHER OPERATIONS

CHAPTER 1
INTRODUCTION TO COLD WEATHER OPERATIONS

SECTION 1
GENERAL

AIM

1. To provide the tactical and operational doctrine for all-season operations in areas of cold and extreme cold, which may but will not necessarily include far northern areas. As significant portions of the Canadian land mass are located within the Arctic, much of this work is directly relevant to operations in the Canadian Arctic.

2. It is recognized that major combat operations are unlikely to be fought in the Canadian, European, or Asian High Arctic in the foreseeable future. However, it must also be stressed that such operations, although difficult, would not be impossible. Finnish, German, and Russian Corps level operations during the Winter War and the two world wars have shown that it is possible to operate significant forces in the Arctic environment. The US and Canada also conducted operations against the Japanese on a significant scale in the Aleutian Islands of Alaska during World War II, and the Korean war was fought in conditions of extreme cold during the winter months. More recently, CF operations during the winter in the former Yugoslavia and in Afghanistan can be classified as cold weather operations, particularly when conducted at high altitude. These historical events not only show that cold weather operations routinely occur, they also show what happens to military forces, large or small, that are not trained, equipped and mentally prepared for the rigours of operations in areas of extreme cold. Canada is an Arctic nation, and the CF must be prepared to operate throughout its Arctic territories, including on and under the sea and in the airspace. Regardless of the size of an operation or its purpose, the basic concepts of operations in this manual are valid.

3. For the purpose of this manual, “cold weather operations” are defined as operations conducted in temperatures from +8 degrees Celsius down to -20 degrees Celsius, and “extreme cold weather operations” are defined as those operations conducted in temperatures below -20 degrees Celsius, regardless of the actual location. Thus, cold weather operations are conducted in the Arctic and Antarctic regions, on the great plains of North America, Europe and Asia, in any mountainous region above 10,000 feet, and in most deserts at night.

SCOPE

4. This manual discusses cold weather operations, including cold weather warfare, and it thus includes activities across the full spectrum of operations and the effects that cold weather will have on all of them. It discusses cold weather operations in general, emphasizing “survive,” “move” and “fight.” These techniques are valid for operations in any area of extreme cold, anywhere in the world, once regional variations and specific factors are accounted for (for example, specific techniques for mountain operations). They also cover the spectrum from small foot and vehicle Canadian Arctic sovereignty patrols to mechanized operations within the context of formations. The special aspects of communication, engineering and air power are highlighted, and their use in a tactical setting discussed. The vital factor of administration is discussed in some detail.

5. Throughout the manual, the emphasis is on the environment and how it can be used in our favour and against the adversary as well as on the problems it presents to us. Mobility is a factor of prime importance, and a great deal of stress is placed on means of improving our movement techniques. There has been no attempt to reiterate doctrine where it does not differ from conventional operations, and a thorough understanding of Canadian conventional doctrine is necessary before this manual can be properly utilized.

6. It is extremely important to recognize the extreme fragility of the Arctic environment. Human activities in the High Arctic can have repercussions and unanticipated consequences for centuries. All CF activities must be carried out with this in mind, and all reasonable precautions to protect the environment must be carried out by all CF members at all times. Canadian laws and regulations will be respected and followed at all times, including environmental regulations. When operating in the cold weather regions of other nations, the CF will follow either the Canadian environmental regulations or those of the host nation, whichever are more stringent. Not only is this responsible behaviour important for preserving the environment, it is also vital for preserving positive relationships with the indigenous populations.

7. The doctrinal concepts in this manual are appropriate in all cold weather regions. While the steppes of Russia and the great plains of North America are not part of the Arctic environment, they do have a very cold winter climate, and the concepts are valid for those areas. While mountain warfare requires some of its own concepts, techniques and constraints that are not covered in this manual, mountainous regions, and certainly those areas above an altitude of 10,000 feet, will have Arctic conditions, at least during the winter months, regardless of their actual location. The Indian and Pakistani armies fought each other for years over the Siachen glacier at altitudes over 20,000 feet, in conditions that in terms of snowfall, ice and temperature could only be described as Arctic.

SECTION 2
COLD REGIONS

GENERAL

1. Cold weather operations occur in all regions where cold conditions and cold weather occur. These areas include the polar regions of the globe and the sub-polar regions linking polar regions to the temperate zones. They also include high mountain regions where extreme cold conditions can occur throughout the year. In Canada, much if not most of the country has those conditions for most of the winter months. However, the Arctic and Subarctic regions, which make up a significant portion of Canada, have more extreme cold weather conditions than the rest of the country for much of the year. Techniques for moving, sustaining and operating in these regions during the winter are equally valid for extreme cold conditions in the south of Canada (or anywhere else) during the winter, and vice versa. It is very unlikely for significant Canadian military operations of any kind to occur in the Antarctic regions, but these techniques would also apply there.

2. About 45 per cent of North America and 65 per cent of Europe and Asia lie within the Subarctic and Arctic area. The land mass contains mountainous regions as well as open, flat or rolling country and lightly to heavily wooded areas. The area is snow-covered for periods of weeks or months, or even year-round. In the mountainous regions, areas of permanent ice fields or glaciers may exist. The Arctic proper is a region of very limited annual precipitation, and while there is a great deal of standing water, it has accumulated over centuries and cannot be regenerated in a short time frame. The Arctic Ocean has heavy ice conditions for much of the year, with ice islands encountered north of 70 degrees N latitude. See Figure 1-2-1 for a map of the world's Arctic regions. The three territories that make up the Canadian North are Nunavut, Yukon and the Northwest Territories.

DEFINITIONS

3. The following definitions will be used by the Canadian Army when conducting operations in the Canadian North (although specific to Canada, in terms of latitude they are also applicable to Europe, Russia and Alaska):

a. The Subarctic region is defined as the area between 55 degrees N and 60 degrees N latitude, encompassing what the Royal Commission on Aboriginal Peoples identified as "Mid-North," and includes large areas of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec and Southern Labrador that reflect northern conditions.

b. The Arctic region is defined as being north of 60 degrees N latitude. In Canada this region consists of the Yukon, the Northwest Territories, Nunavut, Nunavik (Northern Quebec), and Nunatsiavat (Northern Labrador). It extends from Canada's border with Alaska in the west to Davis Strait in the east.

c. The North is defined as the area encompassing the Subarctic region and the Arctic region, including the Arctic Circle and the High Arctic.

d. The Arctic Circle is defined as 66.5 degrees N latitude.

e. The High Arctic is defined as the region above the Arctic Circle.

THE ARCTIC

4. While there are many somewhat conflicting definitions of the Arctic, the Arctic can be defined as that region in which the average temperature in the warmest month is less than 10 degrees Celsius and the mean annual temperature is below 0 degree Celsius. While not absolute, this definition typically describes the area north of the treeline, although small patches of trees may be found there as a result of drainage patterns and microclimates (for example, the south-facing side of a valley). The northern limit of trees is generally restricted to 1 degree Celsius or 110 km north of the treeline. The absence or presence of trees significantly affects the weather on any given day, with trees providing windbreaks, areas for snow to accumulate, etc. In terms of "survive, move and fight," for practical purposes, the treeline divides the Arctic from the Subarctic.

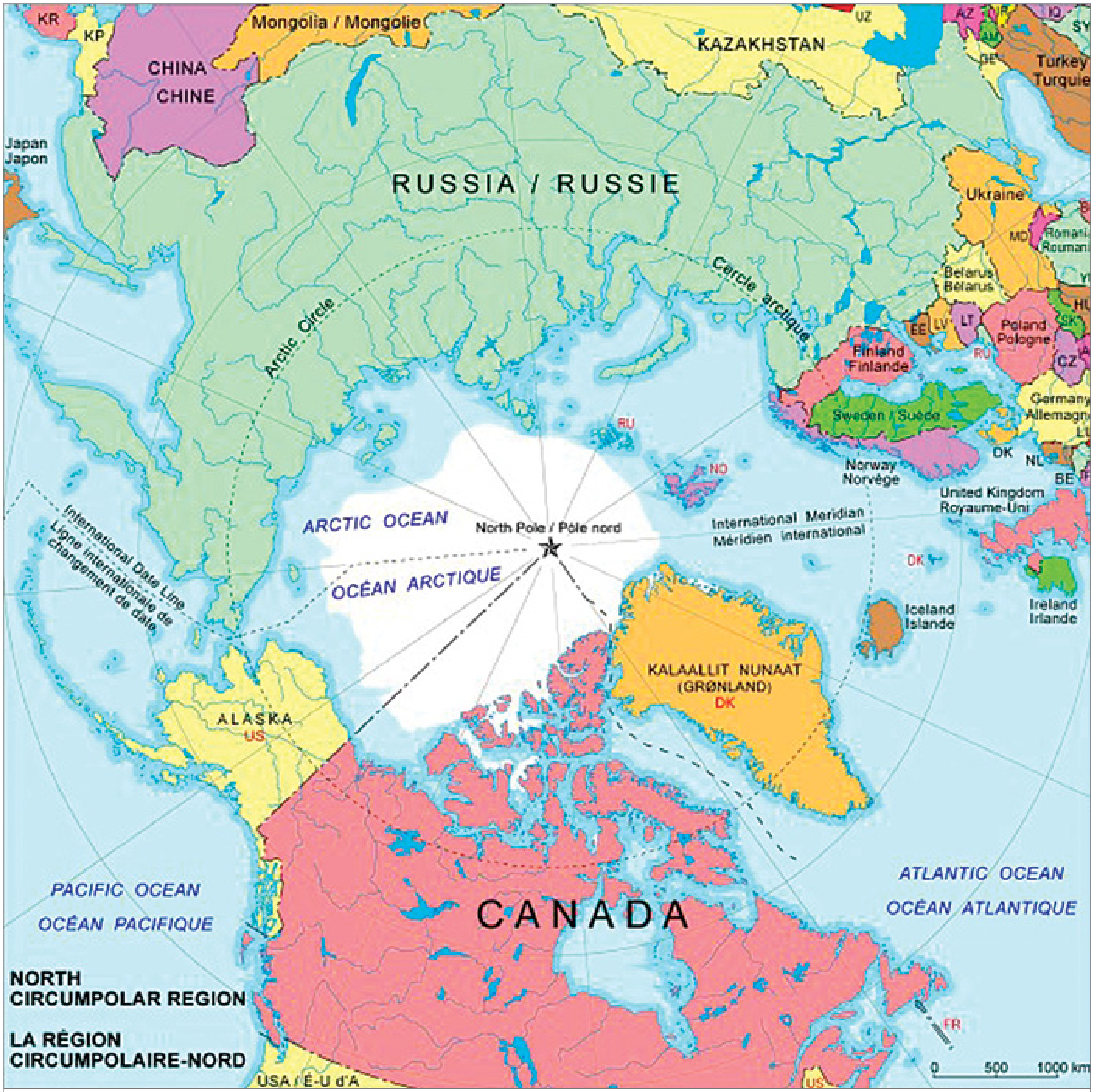

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Figure 1-2-1: The Arctic regions of the world

5. The factors that characterize the Arctic in relation to other geographical regions are:

   a. reception of less solar radiation and, hence, less warming because of the oblique angle of incident solar radiation;

   b. a mean temperature substantially lower than those of temperate regions;

   c. the absence of trees;

   d. an area consisting mainly of an ice-covered ocean and contiguous seas;

   e. wide ranges of duration of daylight and darkness;

   f. many areas receiving no more precipitation than most deserts;

   g. permafrost (permanently frozen ground) preventing drainage, resulting in many lakes and bogs;

   h. long periods of reduced visibility due to blowing snow, ice crystals or fog; and

   i. complete snow cover, which because of the barren ground changes the appearance of the terrain.

6. The Canadian Arctic, which includes the Canadian Arctic Archipelago, contains the largest amount of land in the Arctic. The Canadian Arctic is approximately 40 per cent of the total area of Canada. About three-quarters of Greenland (an autonomous country within the Kingdom of Denmark) lies within the Arctic. Greenland is the largest island land mass in the Arctic. Only small portions of Alaska, Norway, Sweden, Finland and Russia are actually within the Arctic Circle. Iceland, although almost entirely outside the Arctic Circle, is generally considered an arctic country and is part of the Arctic Council. Transportation networks are typically not highly developed in the Arctic. Air transport and seasonal shipping and trucking routes are the main means of moving goods to remote Arctic settlements. The shipping season obviously occurs during the short summers. Interestingly, the trucking season usually occurs in the dead of winter, often on roads prepared primarily on lake and river ice.

Figure 1-2-2: Canadian High Arctic near Resolute Bay, Nunavut, winter

THE SUB-ARCTIC

7. The Subarctic may be defined as the vast area of climatic transition between the temperate regions and the Arctic. The main difference between the Arctic and the Subarctic is that the Subarctic is the home of the coniferous forest.

8. The factors that differentiate the Subarctic from other geographical regions are:

  a. landscape dominated by coniferous trees;

  b. higher precipitation than in Arctic areas;

  c. areas of discontinuous and continuous permafrost, preventing drainage and resulting in many lakes, rivers and bogs;

  d. extremes of temperature ranging from -57 degrees Celsius in winter to +32 degrees Celsius in summer are common;

e. generally low wind velocity with many periods of cold, calm weather in winter and extremely hot weather in summer;

f. heavy late winter snowfall;

g. spring break-up, producing much local flooding and extreme mud conditions; and

h. due to heavy rains, fall freeze-up can result in a period of muddy conditions corresponding to spring break-up.

9. Sub-Arctic Canada encompasses most of the forested areas, but the main part is north of the more densely populated areas of Canada. Northern Europe and most of Alaska and Russia are within the Subarctic and share the same characteristics. The Subarctic is a primary area for exploitation and development because of its resources. Transportation networks in the Subarctic vary from excellent to poor to non-existent.

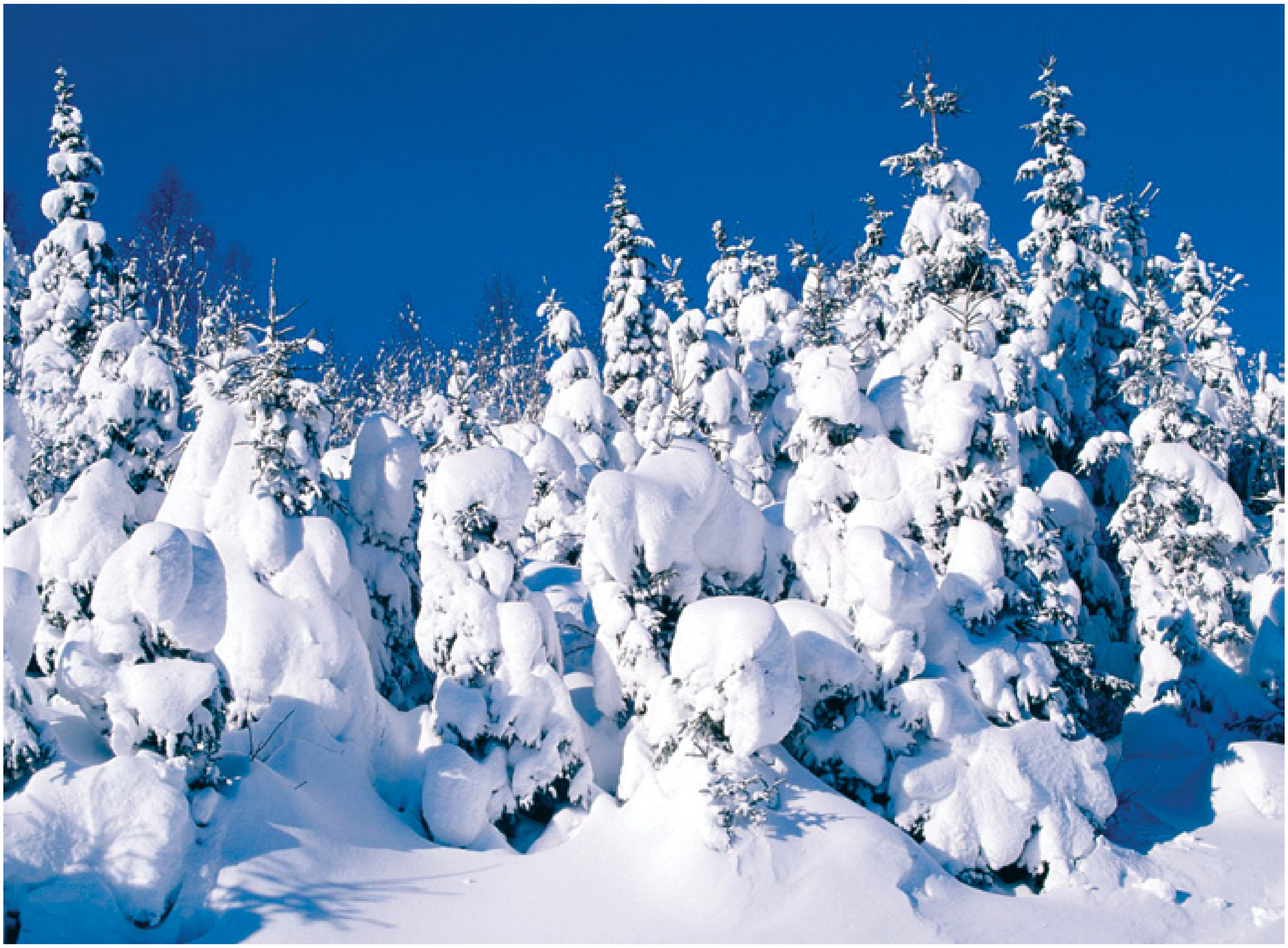

Figure 1-2-3: Heavy snowfall in the Subarctic forest of Northern Ontario

THE ARCTIC OCEAN

10. The Arctic Ocean surrounds the North Pole and is bordered by Canada, Alaska, Greenland, Europe and Asia. Its unique feature is the presence of almost continuous ice cover during the winter months. Throughout the winter, there are breaks in the pack ice, called leads, which are continuously opening and closing, exposing areas of relatively warmer water to cold temperatures. In summer, the contrast between the colder ice and the overlying warmer air causes low stratus cumulus clouds to form, which can inhibit flying both in the Arctic basin and its surrounding islands. Large portions of the Arctic Ocean and the leads between islands can become open water during at least part of the summer. Much of the Arctic Ocean, including the leads and sounds between the Canadian Arctic islands, is typically open to navigation during August and September, but that can vary significantly from year to year. Prior to any deployment, recent ice conditions should be determined.

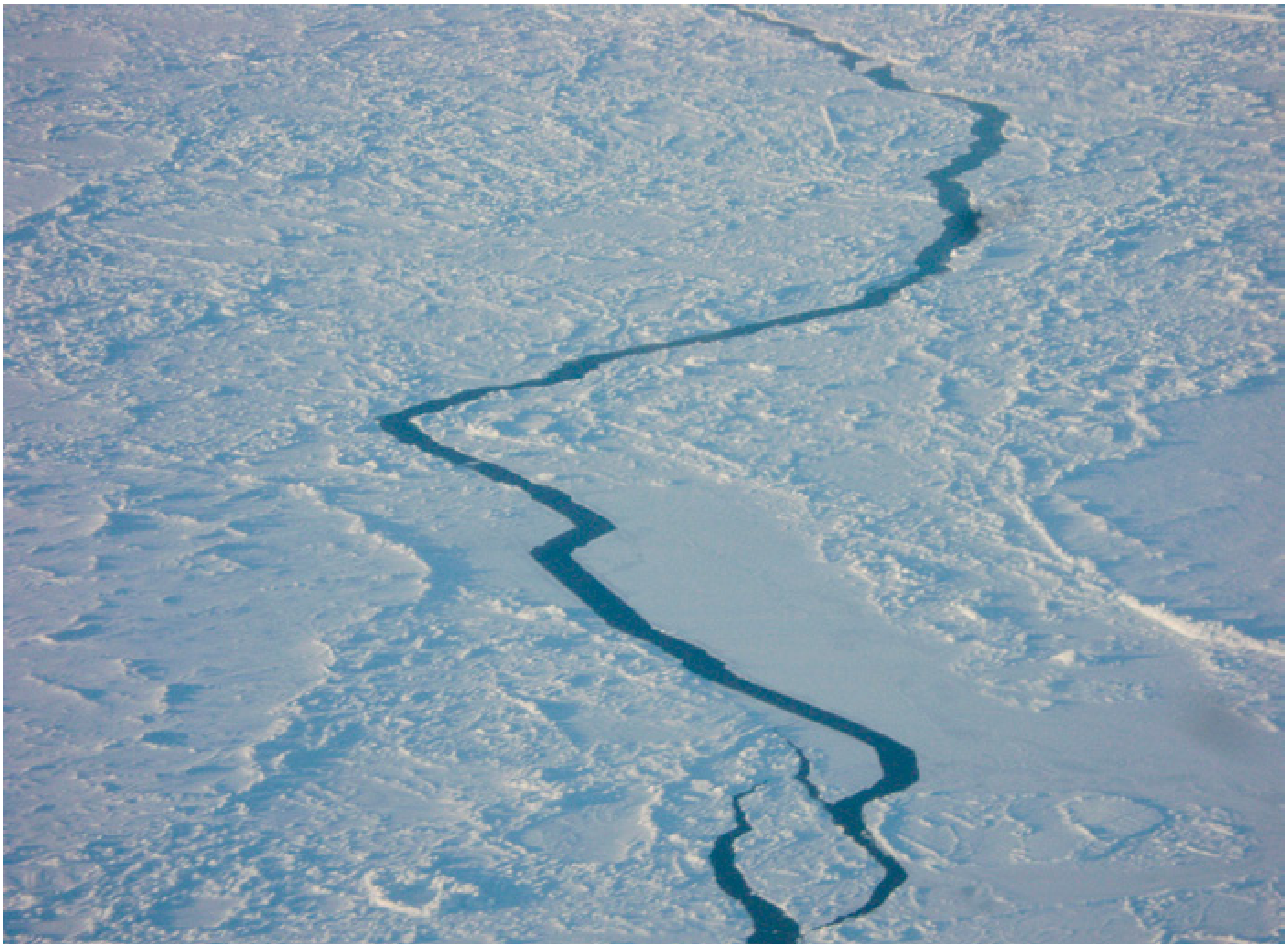

Figure 1-2-4: Lead in the ice pack, April 2010, Northwest Territories

11. Ice islands are very extensive pieces of freshwater ice that circulate in the central Arctic Ocean. They may be tens of kilometres in length and width and can have a height of 7 metres or more above sea level. Such islands can be used as bases for both fixed and rotary-wing light aircraft.

12. Throughout the Arctic basin there are a large number of multi-year ice floes. These ice floes consist of large areas of old sea ice which may be as much as 9 metres thick. These ice floes have been used as sites for research and meteorological stations on which light and sometimes medium aircraft have been based.

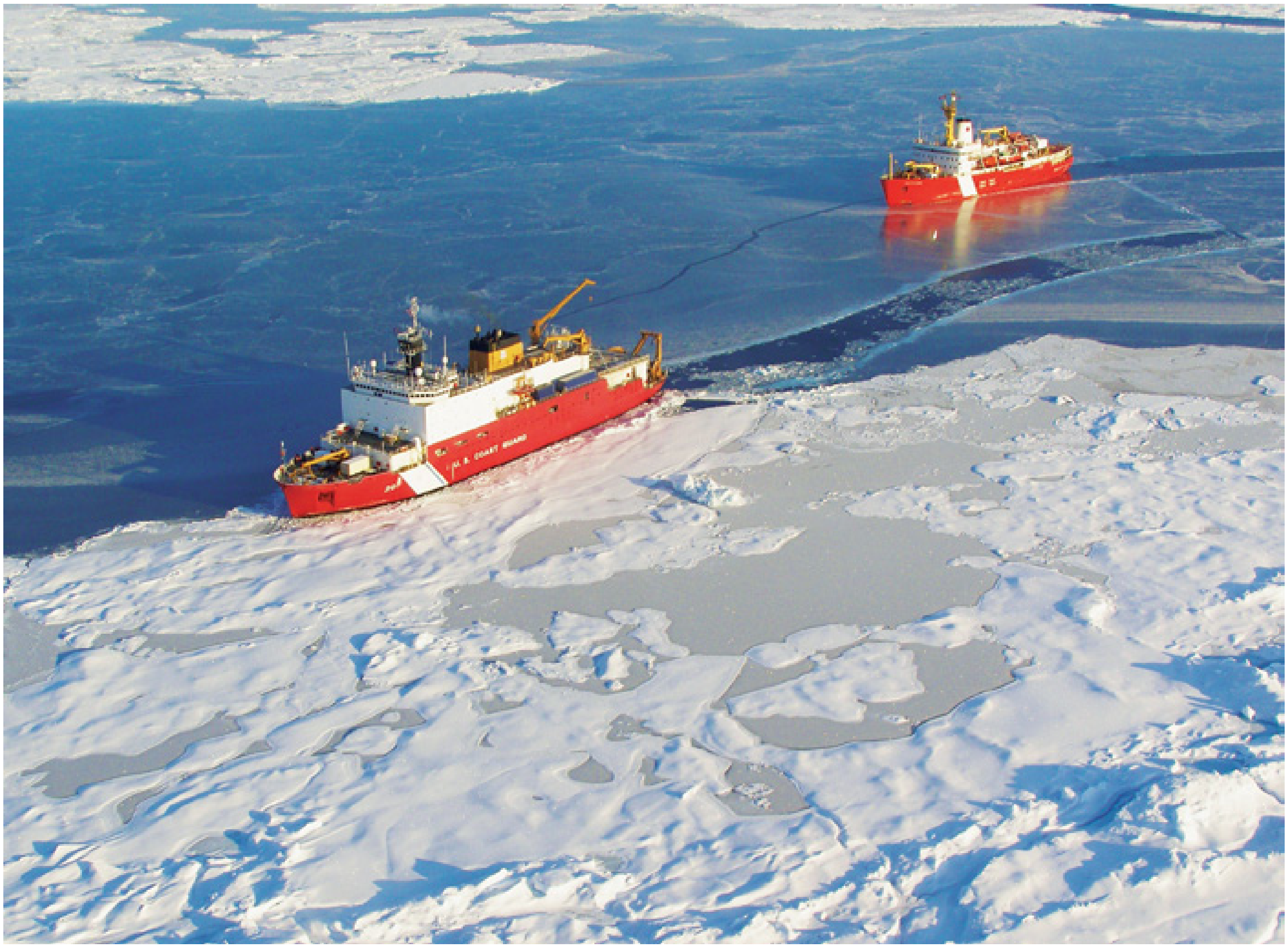

Figure 1-2-5: USCGC Healy leads CCGS Louis St Laurent through first-year ice in the Arctic Ocean, summer 2008

MOUNTAINOUS TERRAIN AND GLACIERS

13. Other regions of consistent cold conditions are the mountainous areas throughout the world. For every 330 feet (approx 100 metres) of altitude gained, ambient temperature will decrease by 1 degree Celsius. This means that if the temperature at sea level is +30 degrees Celsius, with the exact same conditions at 10,000 feet, the temperature will be 0 degree Celsius. As a result, the peaks of almost any mountain in the world over 10,000 feet will have at least some snow cover all year. Depending on altitude and precipitation, glaciers may form. These are permanent ice fields that flow down the side of the mountains. Glaciers actually flow a few feet every year, and as a result deep fissures can open up in the ice. Operations on mountains and glaciers can easily become operations in extreme cold conditions, and many of the shelter, movement and fighting techniques described in this manual will be valid in those conditions. In addition to cold weather techniques and skills, fighting in mountainous areas including glaciers will also require specific training in mountain ops and special equipment such as ropes, ladders, ice axes, ice picks and crampons.

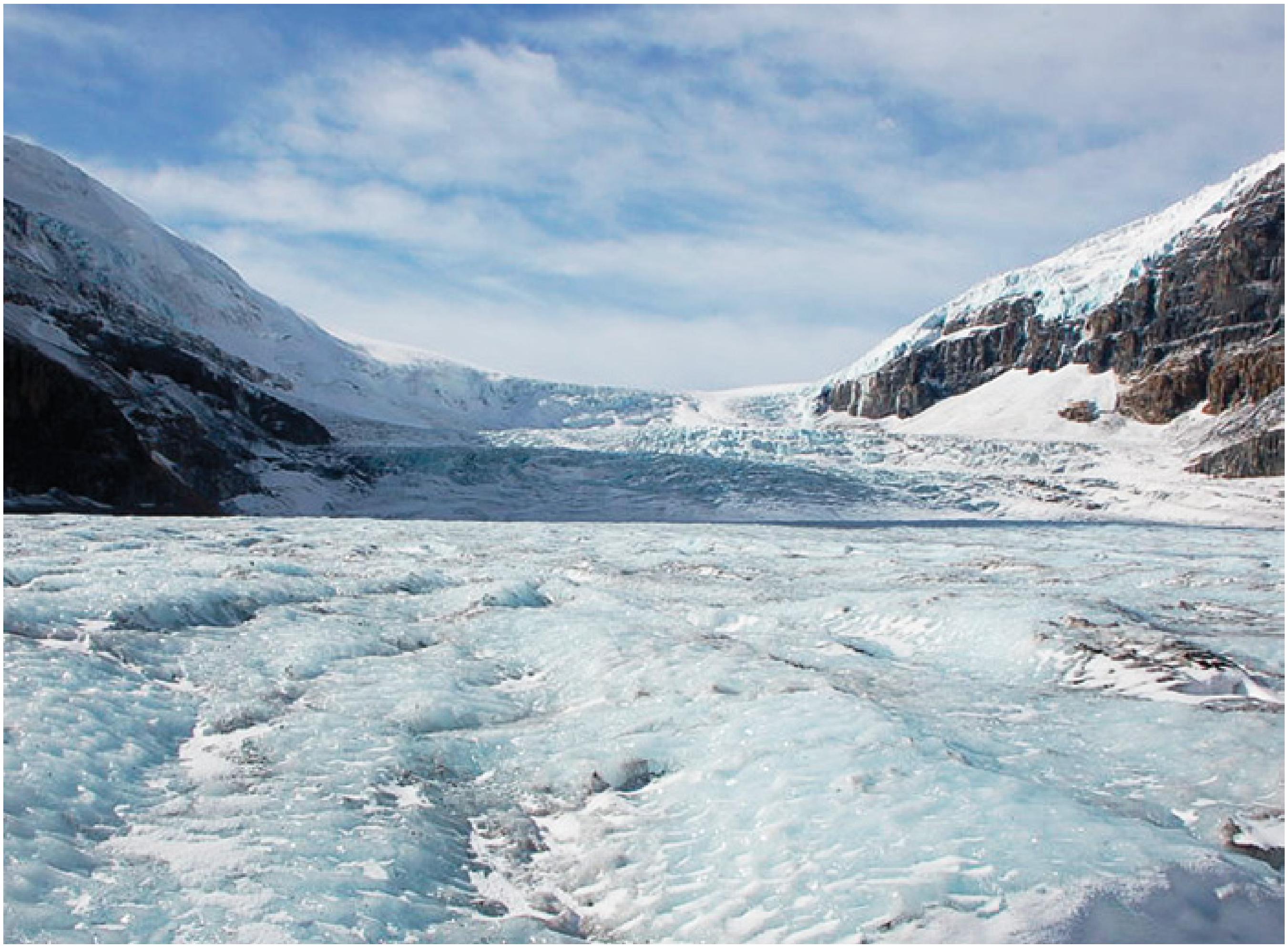

Figure 1-2-6: Columbia Icefield glacier. Alberta, Canada

SECTION 3
OPERATIONAL CONCEPTS

GENERAL

1. Cold weather operations will vary greatly depending on the threat and the theatre. For example, conventional war will require a different approach from Counter-insurgency (COIN) operations, and those approaches will differ significantly from Europe to North America and between the Arctic and Subarctic regions. The CF must be prepared to conduct operations across the spectrum of conflict in all cold weather areas. This includes Major Combat, COIN, Peace Support, Peacetime Military Engagement (PME) and Limited Intervention operations.

2. Cold weather operations in austere regions will rely on an integrated CF Air/Maritime/Land/SOF concept for operations and logistics. Any CF operation in Canada or any other cold weather area will be part of a whole of government approach, including any or all of federal (specifically including RCMP in Canada), provincial and territorial governments, municipal governments, other government departments (OGDs), and quite possibly non-government organizations (NGOs). It will also rely on informal local community leadership, for example, indigenous community elders, members of the clergy and local businesspeople. It may also include local formal and informal groups of the indigenous peoples of the region in question, for example, the local Hunters and Trappers' Association. Obviously, when operating in another country similar relationships should be sought out with the host nation and coalition partner organizations.

3. Canadian Arctic operations will almost always rely heavily on Canadian Ranger (CR) support for guidance, advice and survival skills.

4. Cold weather operations, particularly those in the Canadian Arctic region, will rely on consistent, rapid and thorough surveillance assets, including space systems, LRP aircraft, Ranger patrols, and OGD (eg, Coast Guard, Ministry of Transportation) assets to ensure that the national, provincial and local governments always have as clear a picture as possible of what is occurring in the region.

5. Operations in the Arctic and Subarctic will be restricted by climate, terrain and transportation infrastructure. Particularly in the Arctic, they will be heavily dependent on air operations. Operations in the Subarctic are much easier to support due to increased infrastructure, including roads and railways. This is particularly true of operations in the European Subarctic, where it is quite possible to support large-scale mechanized forces for long periods of time due to the significantly better transportation infrastructure.

CANADIAN ARCTIC OPERATIONS

6. Due to the terrain and climate in the Canadian Arctic, it is extremely difficult, but certainly not impossible, to support a large force over a long distance. Air movement and supply will be extremely important regardless of the size of the force involved. Even forces landed from ships with vehicles will have a difficult time moving and being supplied over difficult terrain, particularly once they have moved away from their beachhead. This significantly reduces, but does not eliminate, the possibility of large-scale military operations. With regards to operations in the Canadian Arctic, threats and tasks that the LF in conjuncture with the CF must be prepared to deal with range from large-scale conventional operations down to relatively small-scale raids against specific targets, possibly as a diversion, and criminal activities including human smuggling. In the Canadian High Arctic, environmental and safety

issues due to increased shipping and civilian air traffic must be accounted for, including providing assistance to Search and Rescue. The LF must be prepared to conduct disaster and humanitarian relief operations, surveillance operations, and assistance (armed or unarmed) to OGDs, local authorities and communities. The LF will also conduct SOVOPS and collective training in the Canadian Arctic and Subarctic.

COLD WEATHER OPERATIONS AROUND THE WORLD

7. Significant portions of the world experience cold or extreme cold conditions on a regular basis. The CF must be trained and equipped to conduct operations across the full spectrum of conflict in these conditions. Although currently unlikely, the possibility of major conventional military operations in Arctic or Subarctic conditions around the world cannot be totally discounted. While recognizing that the likelihood of large-scale peer-on-peer military operations is very low, the CF must be prepared physically and mentally to operate in regions of extreme cold on both a small and a large scale. In order to develop this capability, the CF must also conduct relatively large-scale exercises in cold conditions on a routine basis. See Figure 1-3-1 for the world's cold weather areas.

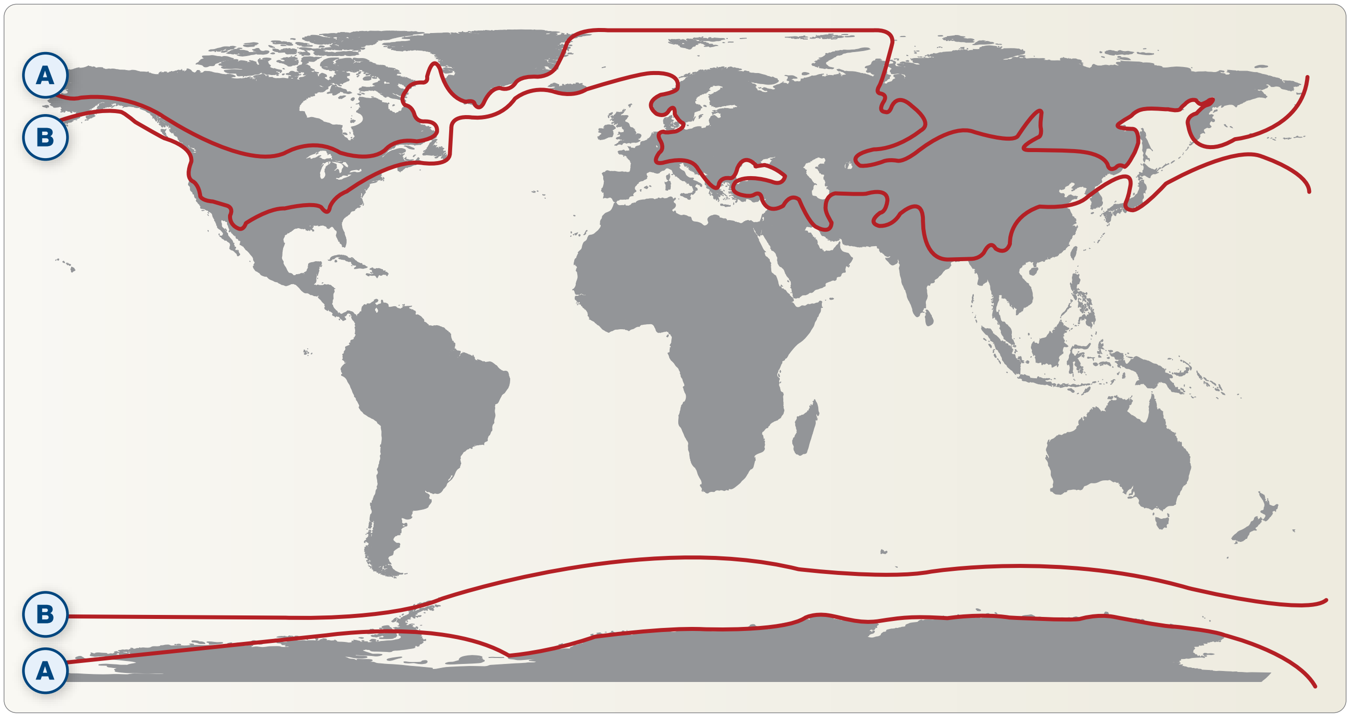

Figure 1-3-1: Cold regions of the world

Regions north of the line marked A in the northern hemisphere and south of the line marked A in the southern hemisphere show regions where extreme cold conditions exist for much of the year. Between lines A and B in both hemispheres are the regions where cold conditions will routinely occur and where extreme cold conditions may occur for at least parts of the year. This does not take into account high mountainous regions (the Andes in South America, for example), deserts at night or warmer microclimates throughout the cold regions.

CHAPTER 2
THE ENVIRONMENT

SECTION 1
INTRODUCTION

GENERAL

1. The environment is defined as the surroundings or conditions in which a person, animal or plant lives or operates. It is the environment of cold regions that is the dominating factor in military operations in those areas. Climate, terrain and the lack of infrastructure are the principal environmental factors which must be considered. While cold weather is not, by definition, season- or location-dependent, the fact remains that areas within the Arctic (or Antarctic) will typically be much colder than other areas of similar topography outside of the Arctic regions, at least during the winter season.

2. The principles of war and the elements of tactics do not change in cold and extreme cold conditions. What is different is the emphasis placed on them in order to use the existing environment to the best advantage. In any operation, whoever deals most successfully with the environment will succeed.

SEASONAL COLD WEATHER OPERATING CONDITIONS

3. While cold and extreme cold conditions are not necessarily seasonal (ie, occurring in winter), it is more likely that cold conditions will be encountered for extended periods of time and over large areas during the winter season for the area in question. For this reason, seasonal differences in conditions must be understood and taken into account.

4. **Winter.** The most suitable time for ground operations in cold regions is from midwinter to early spring before the snow melt and ice break-up. Below the treeline the snow is settled, and above the treeline it is packed, giving improved mobility in the Subarctic and excellent going in the Arctic. In early winter, after the formation of ice on major water bodies but before the heavy snows, cross-country movement is improved, but careful reconnaissance of ice crossings is essential. Winter requires the use of heavy clothing, as well as heavy fuel consumption, both for movement and for heating. Tracks in the snow and fog created by heat sources complicate camouflage issues. The blending or masking of terrain features makes land navigation more difficult. High winds and whiteout conditions can interfere with air operations. High winds can make moderately cold weather dangerous. In northern regions, extended periods of darkness dictate that most activities will be carried out during periods of restricted visibility.

5. **Spring.** Spring is characterized by increasing periods of daylight, light winds, and warmer weather. Daytime thaws and night-time freeze-up leave only a thin layer of mud on the deeply frozen ground. Lake and stream ice is still firm. Limited operations are feasible if timed for the period of easy movement when the daytime thaws are countered by the night frosts. However, these operations may be interrupted by a sudden break, causing them to either slow down or stop entirely. Fortunately the spring break-up period is normally very short, numbering only three to four days in the High Arctic, and limited to a period of a few weeks in the Subarctic. There were several instances where major offensives by both sides on the Russian Front during World War II were completely halted for several weeks by muddy conditions during the spring thaw.

6. **Summer.** From the end of break-up season through to the autumn, operations can be resumed only after the ground has dried up sufficiently to allow cross-country movement. The permafrost table will recede during the summer, therefore deep mud conditions will increase during the summer. During operations in low areas, the numerous streams and swamps will require special equipment and greatly increased engineer effort. The many lakes, rivers and streams may also be used for the movement of troops and supplies.

7. **Autumn.** Late autumn and early winter is the period of most difficulty. Autumn rains, wet snow and heavy fog conditions can turn the countryside into a morass. Poor drainage may cause low-lying country to become isolated. Roads become flooded, and poorly constructed roads will disintegrate. The permafrost level begins to rise, and with the arrival of night frosts and cool days, surface freezing increases. By late September in the Arctic, the surface is normally firm enough to support light tracked vehicles, although the rivers and streams are still open. Full cross-country movement is normally possible (with thorough reconnaissance) by early December north of the treeline and by mid-December through most of the Subarctic.

SECTION 2
CLIMATE

GENERAL

1. Climate is defined as the general weather conditions prevailing in an area over a long period of time. Although the Arctic and Subarctic are generally perceived as a great mass of frozen wasteland, there is considerable variation in seasonal and geographical conditions. For example, almost half of Norway lies north of the Arctic Circle, but the climate there is much more temperate, with much greater precipitation than similar latitudes in Canada due to the influence of the Gulf Stream. Climatic records for any region must be consulted in order to make accurate predictions for operations.

THE ARCTIC

2. **Temperature.** The coldest temperatures in the north occur in the Siberian Subarctic below the treeline. However, in the Canadian Arctic, there are areas where high wind speeds produce much higher wind-chill values than occur in treed regions. At the same time, sheltered valleys and southern exposures can also produce much warmer local temperatures for short periods of time. Temperature can vary significantly over short periods of time.

3. **Precipitation.** Nearly all of the Arctic has a mean annual precipitation of less than 38 cm, of which two-thirds is likely to be summer rainfall. Some of the islands of the Canadian Arctic may receive less than 13 cm, and the ground is almost bare of snow throughout the winter. Winter snowfall in the interior of the North American continent is, on average, less than 76 cm, although in Norway, Labrador and parts of Baffin Island it may be greater than 380 cm a year. Snowfall often appears to be greater than it really is because the snow is frequently picked up by winds in excess of 16 km/hr, giving the impression of a snowstorm. This is particularly true of areas on the west coast of Hudson Bay, where visibility is reduced by blowing snow during approximately one-third of the mid-winter season. This visibility restriction lessens with height above ground, but turbulence in built-up areas will reduce visibility, making vehicle movement very difficult, while vehicles outside the built-up area may be able to operate unhindered. This effect can vary considerably due to wind speed.

4. **Fog and Clouds.** Low stratus cloud and fog are very common in the winter months because of the movement of warmer air masses over cold surfaces. Once the freeze-up is complete, winter is generally a comparatively clear season, particularly for flying.

5. **Wind Chill.** Wind chill is the term applied to the cooling effect of the atmosphere on any surface having a temperature similar to that of human skin. It is a function of wind speed as well as temperature. The wind-chill chart at Figure 2-2-1 shows the Environment Canada wind-chill values. It indicates how the actual temperature combined with the wind speed feels on exposed skin. Medical personnel can explain in greater detail how the phenomenon works, but, in general terms, a cold wind blowing across exposed skin will remove a layer of insulating air and make the temperature seem colder than it actually is. This will cause exposed skin to react accordingly. For example, -15 degrees Celsius with a wind speed of 5 km/h will feel like -19 (Note that the degree symbol is not used for wind chill, since the temperature is not really -19, it just feels like it) and -15 degrees Celsius with a wind speed of 80 km/h will feel like -31. Any windbreak will decrease the wind-chill factor by reducing the wind speed. Although wind chill is usually thought of as the effect on naked skin, it will also affect the rate at which machinery cools or ice forms on water bodies.

6. Seasonal Variations. Seasonal climate variations are as follows:

   a. **General.** In the Arctic, winter generally extends from late September to early May. Spring lasts from late May to the end of June, summer from early July to mid-August, and autumn from late August to late September.

   b. **Seasonal Variations in Sunshine and Darkness.** Seasonal variations in solar radiation are much greater in the Arctic (and Antarctic) than in other regions. There is a period in winter when the sun never rises and one in the summer when the sun never sets. The length of these periods varies from a minimum of one day at the Arctic Circle to a maximum of six months at the North Geographic Pole. Maximum solar heating is received during the third week in June. Less heat is received than at lower latitudes because the sun's rays strike the Arctic regions at an oblique angle. A tent or wall or hillside at right angles to the sun receives as much heat as does ground level at the equator when the sun is at its zenith, and possibly more because of the lack of water vapour in the atmosphere.

   c. **Seasonal Variations in Snow and Ice Cover.** Snow and ice cover in the Arctic is at a maximum in late March and early April. At that time the ocean is covered by ice, except for small leads. Once melting begins in the spring, it proceeds extremely rapidly, so that except for hilltops and gullies, all islands and the mainland are essentially snow-free by the middle of June. Much of the permanent ice sheet does not melt in summer, but its surface becomes wet and is generally covered with pools of melt water. Rivers and lakes become ice-free in late June or even later, depending on latitude. Rivers may remain open until about mid-October. There can be considerable variation in the extent and dates of the melt from year to year.

WIND CHILL CHART: TEMPERATURE (°C) / WIND SPEED (KM/H)											
	5°C	0°C	-5°C	-10°C	-15°C	-20°C	-25°C	-30°C	-35°C	-40°C	-45°C
5 km/h	4	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53
10 km/h	3	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57
15 km/h	2	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60
20 km/h	1	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62
25 km/h	1	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64
30 km/h	0	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65
35 km/h	0	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66
40 km/h	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68
45 km/h	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69
50 km/h	-2	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69
55 km/h	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70
60 km/h	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71
65 km/h	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72
70 km/h	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72
75 km/h	-3	-10	-17	-24	-31	-38	-45	-52	-59	-66	-73
80 km/h	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74

Figure 2-2-1: Wind-chill chart

THE SUB-ARCTIC

7. **General.** The main difference between the climate of the Arctic and that of the Subarctic is that the Subarctic receives more precipitation in all seasons. In winter there is abundant snowfall, generally not less than 125 cm, and sometimes well over 500 cm. In the other seasons, rainfall is also greater, averaging 25 to 50 cm (or more) in the coastal regions. Summer is longer than in the Arctic and mean temperatures range from 10 degrees Celsius to 15 degrees Celsius, with highs occasionally exceeding 30 degrees Celsius.

SPECIAL PROBLEMS

8. **Ice Fog.** Ice particle fogs are a very common occurrence around inhabited areas during cold winter weather. They generally occur when temperatures drop below -37 degrees Celsius. Unlike super-cooled fogs, ice particle fogs form when a large volume of water vapour is produced locally by human activities and the stagnant air is unable to hold the water vapour at such low temperatures. Human-generated sources of water vapour may include the exhaust from vehicles or aircraft, the vents of steam from heating systems, the air vented from humid rooms, and the stovepipes from space heaters, etc. In the field, such a fog may appear over a body of troops, bivouac areas, vehicle parks, airfields, convoys, and gun positions when firing. Ice fog obscures the gunner’s vision along the line

of fire, and may disclose the location of vehicles, weapons and troops. During darkness, ice fog may limit the effectiveness of night-vision devices. In an attempt to reduce the impact of human-made ice fog on air operations, most airfields are located at least a few kilometres from the adjacent town.

9. **Whiteout.** Whiteout is a milky atmospheric phenomenon in which the observer seems to be engulfed in a uniformly white glow. No shadows, horizon or clouds are discernible. Sense of depth and orientation are lost. Whiteout occurs over an unbroken snow cover beneath a uniformly overcast sky. The whiteout phenomenon is experienced in the air as well as on the ground. Its effect on those experiencing it is a feeling of uncertainty. The quiet, eerie atmosphere, coupled with the loss of the third dimension of viewing, can make one feel completely isolated. There are many stories about whiteouts, but the phenomenon has been exaggerated. In fact, the conditions that cause whiteouts very rarely occur. A vehicle can move in whiteout conditions, particularly if it is dark-coloured and the navigation aids do not require a visual reference. However, movement in mountainous regions or over ground with high snow anvils becomes difficult because the driver cannot see changes in the terrain due to the loss of depth perception on a white surface. People who live in the Arctic always watch for a melding of horizon and sky on an overcast day with low winds to give them warning of this condition. Whiteouts are normally encountered on sea ice and on large frozen lakes, flat plateaus, and flat prairies with no bare rocks, trees or other features. Aircrew will often encounter whiteout on takeoff or landing. This can be countered by placing 45-gallon drums or similar markers around the landing strip or zone, or by parking dark vehicles along the edge of the strip in order to give the pilots a useable reference point.

10. **Greyout.** Greyout is a phenomenon which occurs over a snow-covered surface during twilight conditions or when the sun is close to the horizon. There is an overall greyness to the surroundings. When the sky is overcast with dense cloud there is an absence of shadows, resulting in a loss of depth perception, which increases the hazards of landing an aircraft, driving a vehicle, skiing or even walking. The greatest effect is felt when a person is fatigued. Under certain greyout conditions it has been found that it is almost impossible to distinguish the road from the ditch when driving. The phenomenon is similar to whiteout except that the horizon is distinguishable under greyout conditions. Staying on course is not a problem, as the horizon will serve as a reference point, but ground conditions cannot be clearly observed. Movement is more difficult for the lead vehicles, but the use of vehicle lights will help.

SECTION 3
TERRAIN

GENERAL

1. Terrain can be defined as a stretch of land, especially with regard to its physical features. There is a great variety of terrain features in the Arctic and Subarctic regions, and whichever side can best utilize these features will operate at a significant advantage.

THE ARCTIC

2. **Tundra.** Tundra is flat or gently rolling country composed of a rock surface or muskeg over permafrost. Its chief characteristic is the absence of trees. The tundra is made up of several transition zones of vegetation which decrease in density from south to north. Bush tundra is composed mainly of dwarf trees of willow, birch, alder and mountain ash species and borders the coniferous forest line. The shrubby tundra further north is composed of a nearly continuous mat of shrubs such as Labrador tea, and the grassy tundra even farther north is composed of mosses and lichens mixed with small shrubs that lie flat on the ground. Finally, the grass tundra breaks up into scattered groupings of vegetation in sheltered hollows separated by bare rock. This is called desert tundra.

3. **Muskeg.** This is a cover of organic material overlying mineral soils which has a living cover of mosses, shrubs, grasses and small trees. Muskeg is a formidable obstacle to overland travel in both summer and winter due to frozen hummocks up to a metre high.

4. **Permafrost.** Permafrost is perennially frozen ground, and it is found throughout the Arctic and in much of the Subarctic. The average annual permafrost thaw in the Arctic is from 0.5 metres to 1.5 metres, and this depth of thaw is called the active layer. However, the annual thaw can vary from as little as 10 cm on Ellesmere Island to as much as 2.5 metres at Yakutsk on the east coast of Russia. Permafrost restricts surface drainage to the active layer, and this layer is frequently saturated with slow-moving water. Any surface disturbance will collect water, and if such a disturbance provides a channel in the direction of the watershed, surface water will flow along that channel. The flow may wash away or otherwise alter the vegetation that binds the surface and insulates the permafrost. That in turn deepens the active layer and creates the effect of a drainage ditch, which in turn again increases the flow of water in the channel. Under certain conditions this cycle may convert a single-vehicle track into a destructive ditch of erosion. Such ditches may last for centuries and have a pronounced effect on the local ecology. For this reason (disruption of permafrost), the digging in of defensive positions in areas of permafrost is not suggested. The solution is to build up rather than dig down. The same is true for gun and mortar positions.

5. **Inland Waters.** Since precipitation in the Arctic is so low, streams have relatively little volume. Melting snow in the warm months can produce sudden variations in the flow. The rivers of the Canadian Arctic mainland usually open sometime between mid-May and mid-June. In comparison, the larger lakes ordinarily are not open until mid-July, and in some years not at all. Ice expansion, continual water inflow, and partial thaws may create pressure ridges in the lake ice. These ridges, often several metres high, can prove to be formidable obstacles to vehicles. The ice of Arctic lakes may be at least 2 metres thick, but that depends more on the snow cover than on the average temperature. The maximum thickness is attained only when the snow is sparse or the ice is swept clean of snow by the wind. When thick snow cover insulates the ice early in the winter, only a few inches of ice may form, and motorized travel on such ice is dangerous even in very cold weather. Actual ice thickness and the duration of ice cover can vary significantly from year to year. Recent local records should be researched before any operation or exercise.

THE SUB-ARCTIC

6. **General.** For the purposes of military operations, the separation between the Subarctic and the Arctic is defined by terrain and vegetation. Forests of spruce, alder, birch and pine interspersed by rivers, streams, lakes, and swamps dominate the Subarctic landscape. The relief varies from the smoothly rolling or nearly level country of the Canadian Northwest and Siberia, through the hilly relief of Norway with its deep fjords, to the mountains of British Columbia and Alaska.

7. **Forests.** Forested areas of the Subarctic are characterized by closely spaced trees, deadfall, rocky hummocks and boulders, bogs, rivers and lakes. In summer, these all make movement difficult. In winter the problem is eased by the freezing of waterways but compounded by huge, soft snowdrifts which accumulate because of the trees. Time and space calculations must be adjusted to the conditions. It may be very difficult, if not impossible, to move significant forces any distance below the treeline, and local conditions must be taken into account.

8. **Swamps, Rivers and Lakes.** Swamps, rivers and lakes make movement easier in winter but harder in summer. Tactically, they are good approaches in winter and obstacles in summer. In winter, detailed engineer reconnaissance is necessary to determine whether the ice is thick enough for safe use as roads or airstrips. In summer, various biting insects will make life miserable, and the troops must be protected against them.

MOUNTAINOUS TERRAIN AND GLACIERS

9. **Mountains.** Mountains and the combination of forest and deep snow in the Canadian Rockies and in Norway pose particular problems for movement in the Subarctic. Helicopters provide the main means of overcoming these problems, since ground vehicles of any type can seldom be used in the combination of steep terrain and deep snow. Significant portions of the Andes (in South America) and the Himalayas (in Asia) will have similar conditions to the Rockies throughout the year.

10. **Glaciers.** Glaciers are extensive masses of land ice formed by the accumulation and later recrystallization of snow. Glaciers are found on all mountainous islands and some of the islands in the lower Canadian Arctic, throughout Arctic and Antarctic regions, and in mountainous regions throughout the world. Operations on glaciers will require special equipment such as ropes, ladders, crampons, ice picks, etc, as well as specialist training.

SECTION 4
INFRASTRUCTURE

GENERAL

1. Infrastructure is the system of airfields, ports, roads, railroads, telecommunications and public services that exist in a given area. In the cold regions of the world, and particularly in northern Canada, it is the absence of much of this infrastructure that makes it so difficult to conduct major combat activities. Either military operations will have to be conducted without this infrastructure, or the forces involved will have to create their own infrastructure to the extent possible. Some infrastructure does exist throughout much, but not all, of the Subarctic, deserts and mountainous regions. A detailed, up-to-date intelligence summary must be produced for any region in order to know what is available.

PROBLEM AREAS

2. The principal items of infrastructure that are either absent or very limited in regions of significant cold typically include roads, railways, port facilities, sophisticated airports and air traffic control, communications systems and heated shelter, including maintenance facilities for large aircraft, bulk fuel supplies, food stocks and hospitals. What infrastructure exists is separated by vast distances and is required for the inhabitants' use.

3. The next section will discuss the effects this lack of infrastructure will have on military operations. There will have to be heavier reliance on air transport in order to overcome mobility and supply problems. It must be emphasized that there is very little "spare" infrastructure available. What little exists is almost totally utilized by the local population.

DEVELOPMENT AND RESOURCES

4. There is a significant lack of infrastructure in the Arctic regions, and what does exist is due primarily to the natural resources industries. However, the Arctic regions, and the Canadian Arctic in particular, are being developed rapidly. The Minister of Aboriginal Affairs and Northern Development publishes a number of documents that give the status of development in Northern Canada at any time, and other Arctic nations produce similar publications. The latest versions of these documents should be consulted by staffs planning any operation or exercise in Arctic or Subarctic regions.

5. **Resources.** The northern regions of the world are rich in natural resources. In Canada those resources include oil and natural gas, hydroelectric power, diamonds, gold, silver, zinc, copper, nickel, and lead. For example, as of 2010, Canada was the third-largest diamond producer in the world. The Arctic region of Russia is equally rich in natural resources. As mentioned above, due to the presence of natural resources, infrastructure is rapidly being developed throughout the Arctic.

INDIGENOUS POPULATIONS IN NORTHERN REGIONS

6. All cold regions of the world have their own indigenous populations. Through generations of living in these inhospitable regions, all of these groups have developed a culture adapted to surviving there. These indigenous groups are similar in many respects, but also different in many respects. And any operations conducted by the CF in any of these regions must take the needs and wishes of the indigenous people into account. The indigenous people of any remote area can provide a great deal of information about travel routes, weather patterns and survival techniques.

7. The Canadian Aboriginal peoples consist of three distinct groups: the Inuit, the Canadian First Nations, and the Métis.

INDIGENOUS POPULATIONS OF OTHER NORTHERN REGIONS

8. Indigenous populations exist in all northern regions of the world, from Alaska, across Russia, into Scandinavia and Greenland, as well as Canada. These international groups include the Aleuts and Inuit in Alaska, the Sami (sometimes referred to as Laplanders) in Scandinavia, and 41-different groups in Russia, of which the Sakha in Eastern Siberia is the largest. Most desert or mountainous regions have similar populations. These indigenous peoples initially appear to share similar traits, but there are often important cultural differences. Once a CF formation, unit or element is designated for operations in any of these areas, it is extremely important that attention be paid to learning something of the cultural practices and beliefs of the local people. For example, while the Inuit of Northern Canada consider the term “Eskimo” to be somewhat insulting, in Alaska “Eskimo” is the preferred term for several different Alaskan indigenous groups. Needless to say, good relations with these peoples are critical for success across the full spectrum of operations.

SECTION 5
EFFECT OF COLD ON MILITARY OPERATIONS

LEADERSHIP

1. Cold weather operations—and particularly operations in conditions of extreme cold—emphasize small-unit tactics, and command must be decentralized to ensure maximum flexibility. Personal leadership must be forceful and dynamic in cold weather operations because of the demands of the hostile environment. Commanders at all levels must plan and prepare their operations in great detail, actively supervise, keep themselves and their subordinates informed, and maintain close coordination with adjacent and supporting units.

2. A high portion of troops assigned to cold weather operations, especially in Arctic regions in winter, will initially have a basic fear of the environment. This is especially true for troops with limited or no cold weather experience. They will have heard stories of the cold, how difficult everything is and how easy it is to get lost. Mere survival will become their primary focus. An early, major task for leaders at all levels is to overcome this basic fear in their soldiers and to help build the soldiers' confidence to counteract it. A positive frame of mind based on knowledge and experience can make all the difference during operations in the North. Through personal example and discipline, leaders can put thoughts of simple survival in perspective and effectively carry out the mission.

3. Leaders must stress accomplishment of the mission at all times. All cold weather training must be aimed at recognizing that the environment is neutral and that appropriate skills and techniques will allow soldiers to use the environment in their favour and against the enemy. A thorough grasp of Canadian army doctrine and tactics, coupled with a knowledge of cold weather conditions and technical competence, will lead to success.

FORCE PROTECTION AND RISK MANAGEMENT

4. Force protection is defined as "All measures and means to minimize the vulnerability of personnel, facilities, equipment and operations to any threat and in all situations, to preserve freedom of action and the operational effectiveness of the force."[1] During operations in extreme cold conditions, the main factor concerning force protection is simply the environment. In extreme cold, the environment is at least as large a threat as the adversary and will often be far greater. This is particularly true during peace support, peacetime military engagement and limited intervention operations. Special care must be taken in all aspects of operations, including training, to protect the force from the harsh environment. Heated shelter is vital. The difficulties in providing logistical support and the lack of alternative methods for supplying forces must be considered at all times. Commanders must be prepared to accept that extreme climatic conditions can make operations of all kinds simply impossible and to postpone or even cancel activities.

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[1] CF Data Terminology Bank record 23554

MOBILITY

5. The combined effect of climate, terrain, and the lack of infrastructure has a very limiting effect on mobility. This problem is greater in the Arctic than the Subarctic because transport facilities are even scarcer. Air transport will be critical for any operation. A significant portion of the supply system will be used to enable the operation of aircraft. Factors affecting mobility will be discussed in greater detail in Chapter 3.

FIREPOWER

6. Other things being equal, the ability to deliver superior firepower on target will decide the battle. All commanders must strive to reduce their own casualties by employing firepower rather than human resources.

7. Every casualty inflicted on the enemy, every shelter destroyed, every supply column intercepted, will have a cumulative effect on the enemy force. The time, effort and labour involved in recovering, treating, and evacuating any casualty is far greater than in a temperate climate zone. This penalty applies to both sides, and force protection measures must be used to reduce friendly casualties while maximum firepower is applied against the enemy.

8. The factors that restrict mobility in cold weather operations also restrict the ability to apply firepower. Difficulty in moving, limited ammunition resupply, weather conditions, terrain, and battlefield obscuration all affect the application of firepower.

9. During operations in temperate areas, indirect fire (rockets, guns and mortars) is the most effective method of delivering sustained fire with minimum risk to one's own troops regardless of weather. In the past, due to issues with maps, navigation in general, identifying positions, and weather and terrain effects on munitions, indirect fire in Arctic areas was not as reliable as similar fire in temperate regions. However, modern aids such as global positioning systems (GPS) and ballistic computers will improve the speed and precision of indirect fire. Modern fuses, propellants and projectiles work much better in cold weather conditions than they did in the past. However, despite these improvements, indirect-fire weapons will have problems in extreme cold conditions. Electrical circuits are affected by extreme temperatures, as are power sources. Fuses may not function properly in extreme cold, and moving parts can become brittle and break.

10. In cold weather operations, the reliance on aircraft for firepower will be significant. The ability to operate across long distances from prepared facilities with great precision in most weather conditions gives close air support (CAS) a significant advantage. Suppression of enemy air defences (SEAD) may be required in order to allow freedom of movement to allied aircraft, particularly close to the enemy positions.

11. The potential for attack helicopters, whether Canadian or coalition, is also significant. The stand-off ranges of guided munitions can be used to advantage, but the scarcity of protective terrain and vegetation will greatly increase the vulnerability of attack helicopters to even modest air defence systems. The advantage of basing the helicopters close to the front may be offset by the requirement for shelter and heated servicing infrastructure.

LOGISTICS

12. However, no force can achieve the necessary mobility and firepower to destroy the enemy without a sound, robust logistics system. In cold weather conditions, where transport infrastructure may be minimal, significant resources may be required to improve or maintain infrastructure to the point where it can be used effectively to supply the force.

13. All logistics functions will invariably take more time in a cold weather environment. Distance is often measured in time rather than space. Simple tasks take longer to execute due to extremes of temperature, bulky environmental clothing, limited shelter and poor transport facilities. Unpredictable weather also means that holdings at all levels must be carefully planned for, since timely resupply cannot be absolutely guaranteed. There will seldom be sufficient pre-existing infrastructure to hold overstocked stores, and building it will put its own stress on the logistics system.

14. The scope of any operation in cold weather conditions will be limited by the amount of logistical support that can be provided. Logistics must be taken into account at the earliest stage of the planning process so that a mission is tailored to the available resources. Priority in supply must go to combat requirements. Troops must be trained and disciplined to operate with a minimum of “comfort” items. Of all combat supplies, POL will probably be the predominant requirement due to the greatly increased consumption for heating, lighting and continual running of engines. CASEVAC issues must be addressed in the initial planning and will be critical in any logistics plan.

CHAPTER 3
FACTORS AFFECTING MOVEMENT

SECTION 1
INTRODUCTION

GENERAL

1. Mobility is the key to operations in cold weather. This mobility is ideally provided by air vehicles, and in the worst case it is provided by movement on foot. The majority of situations call for overground mobility, and it is this aspect of mobility which is stressed in this chapter. The most probable type of action in conditions of extreme cold will probably involve isolated, small unit actions where the ability to strike fast, cut supply lines, surround patrols, and deliver direct fire from protected weapons platforms will carry the day. This means that all-terrain, all-season vehicles capable of carrying out a number of combat and logistics functions are mandatory.

2. The tactical requirement for mobility must be achieved in spite of the tremendous problems presented by terrain and climate. Although standard military pattern (SMP) wheeled vehicles may suffice in many Subarctic areas, highly specialized high-mobility vehicles will be the key to success in the High Arctic and in the winter season.

3. Mountainous regions may be prone to avalanches during periods of high snowfall. Vibrations from movement or even noise can trigger an avalanche, and some weather conditions make them more likely. Adversaries can deliberately trigger avalanches using artillery, etc. Heavy recent snowfall, a sudden temperature rise, and visible avalanche activity are all significant warning signs. The CF Advanced Mountain Warfare course teaches avalanche awareness, and the Canadian Avalanche Association (CAA) is also a good source of courses and information. Elements operating in areas that routinely experience avalanches must ensure that experienced personnel are available to give expert advice.

SECTION 2
MOVEMENT ON FOOT

SCOPE

1. All personnel on cold weather operations will be involved in dismounted activities at one time or another. These activities could range from sentry duty in the logistics area to a snowshoe or ski patrol within enemy-controlled territory. It is vital that all personnel have an awareness of the special problems affecting operations on foot.

2. The psychological pressures on individuals and the requirement for strong leadership to overcome those pressures are immense. Operations on foot are probably the most difficult in this regard. Each individual must rely solely on themselves and on their own personal clothing and equipment. When they are separated from the vehicle, soldiers must do without the advantages usually associated with it: shelter, mobility, firepower, long-range communications and crew companionship.

INDIVIDUAL LOAD

3. In cold weather operations, individual mobility on foot is determined by the factors of load carried and mobility aids. The criterion should not be what can be carried, but rather what can be left behind. Commanders at all levels must constantly stress minimum loads. Soldiers should carry only those items essential for combat and emergency survival. Often this will only be ammunition and emergency rations, but on some occasions sleeping bags may be necessary. If toboggans must be brought, they should be pulled by follow-up troops, not the lead elements. Forward troops must never be encumbered by unnecessary kit.

4. Modern motorized/mechanical load carriers may be provided to get some of the load off the soldier’s back, but it is unlikely that there will be enough of them, and each soldier must be prepared to carry the bulk of his or her individual load much of the time. Equipment not carried by forward troops must be positioned so that it can be moved forward immediately on demand. Other techniques include the establishment of supply caches of combat supplies well forward and the use of forward supply airdrops.

MOBILITY AIDS

5. Mobility aids for dismounted troops range from snowshoes and skis to motorized load carriers for cargo and/or personnel. The choice of snowshoes or skis will ultimately come down to terrain, the current and expected weather and conditions, and the state of training and experience of the troops involved. The following are some considerations:

   a. Skis afford much greater speed in moving, particularly over prepared trails and open country, and they usually require far less physical effort than snowshoeing. Troops highly trained in the use of skis and towed behind vehicles using long ropes (ski-joring), are an effective means of rapid cross-country movement. Skis take a great deal more practice to master than snowshoes but offer significant mobility benefits to trained ski troops. If time allows, every effort should be made to train soldiers destined for extreme cold weather operations in the use of skis.

b. Snowshoes, although much slower and much more exhausting than skis, require much less training and experience. Troops in good physical condition can develop adequate proficiency in a few hours. Snowshoe movement is most practical in heavily wooded areas, assembly areas, gun positions, and other confined spaces.

6. During conditions of extreme cold, when survival is a prime consideration, the positioning and method of movement of sub-unit tentage, fuel, rations and other items will be a major concern of all commanders. Imagination and improvisation will be required. High-mobility carriers (eg, APCs and oversnow vehicles) must be used to full advantage in support of dismounted troops. Helicopters, particularly medium helicopters, will be invaluable assets.

SECTION 3
VEHICLE MOVEMENT IN WINTER

GENERAL

1. In many cold weather operations, heavy snow will be a prime obstacle to winter movement. In addition, many small lakes and muskeg areas where bacterial action is in progress may not freeze completely. These areas will be dangerous obstacles but they may be identified by differences in snow texture or signs of flooding through the snow. It is extremely dangerous to attempt to cross large areas of muskeg on foot during winter, and such crossings should be avoided.

2. In snowy conditions, snowdrifts will accumulate in the lee of features and can normally be avoided. Snow anvils (densely packed snow formations created by the wind) are another problem—they are more common and can make movement difficult. When crossed at the wrong angle, they can upset a vehicle or cause it to throw a track. When snow anvils cannot be avoided, the route selected should be based on the angle of the snowdrifts.

EFFECTS OF DEEP SNOW

3. It is impractical to establish definite rules for through-snow operations due to the varied conditions encountered. Since experience in each particular area is necessary to accurately predict snow trafficability, reconnaissance must be conducted for each separate action to determine current snow conditions. Low-ground pressure-tracked vehicles can generally operate effectively in deep snow; however, snow greater than 75 cm in depth, especially when granular or powdery, can stop all except oversnow vehicles. The physical strength of snow generally increases as the temperature decreases. A snow-covered area that is impossible to cross during the daytime or in periods of relatively warm temperatures may become easily passable at night after a sharp drop in temperature. Above the treeline, SMP vehicles can often operate as oversnow vehicles once the temperature drops below -34 degrees Celsius.

4. In dry snow conditions, the ability to negotiate terrain by using tracked vehicles is improved. Normal speeds may be maintained after a packed snow trail has been formed by several vehicles. The surface of a packed snow trail becomes compacted into a hard mass resembling well-packed wet sand and is easily traversed by all SMP vehicles. In addition to their normal roles, tracked vehicles are capable of towing or carrying heavy loads such as toboggans or support weapons on sleds, and are excellent for ski-joring troops. When moving in column, extra loads should not be included with the first two subunits. This will allow them to select the route or fight if necessary in order to allow the rest of the column to deploy.

5. In the event of a thaw, proper driving techniques must be used to prevent vehicles from becoming bogged. Freeze-up frequently follows thaws, and it produces glare ice which makes trails practically impassable to tracked vehicles, particularly on slopes of 30 degrees. Proper driving techniques must be emphasized, as under these conditions it is desirable that all vehicles trail the lead vehicle. The rubber pads of armoured vehicles should be removed when conditions are nearing the freezing level. At temperatures below -2 degrees Celsius, grousers should be installed on the tracks to prevent slipping and sliding. Wet, clinging snow has a tendency to accumulate on the tracks, suspensions, idler wheels and drive sprockets, and it must be removed to prevent damage to the suspension and the throwing of tracks. If the vehicles are halted for any period of time, this snow

and slush must be removed to prevent freezing. Once the temperature drops well below freezing, the rubber track pads should be refitted to the tracks. However, during periods of extreme cold, rough ground that is only lightly covered in snow can easily damage rubber track shoes.

ICE CROSSINGS

6. Lakes and streams may be crossed on the ice during the winter and spring months if the ice is thick enough and reasonable precautions are taken. For example, a minimum of 33 cm is required for a one-vehicle crossing, and 45 cm is required for a multi-vehicle crossing at -18 degrees Celsius. Crossing routes—and particularly the entrance and exit points to the crossing—must be inspected for cracks, pressure ridges and thin spots before vehicles are placed on the ice. Lakes above the treeline freeze rapidly and are normally quite safe between early December and mid-April.

7. With an average temperature of -18 degrees Celsius over a period of fourteen days, a typical APC can be supported by freshwater ice. However, this must be verified at the location by measurement, as local conditions can make a significant difference. Snow-covered lakes in particular can have heavy snowdrifts, usually on the side to which the prevailing wind blows, and by acting as insulation this snow cover can have a significant effect on the rate of freezing, resulting in thin ice. Note that snow-covered ice can be rapidly thickened by removing the snow and exposing the ice to the cold air temperature.

SECTION 4
VEHICLE MOVEMENT IN OTHER SEASONS

SPRING BREAK-UP

1. The poor going conditions during the spring thaw may seriously restrict the movement of tracked and other vehicles. During the spring break-up, where possible, vehicles should not follow in the tracks of others, and they should move where the permafrost table is sufficiently high to preclude a vehicle from becoming mired. Gravel ridges should be selected as routes where possible. In wooded areas where permafrost is near the surface, routes should be selected on the shaded slopes of hills, on the shaded sides of woods, on ground with good moss cover and on crests where drainage is good.

2. Extreme caution is necessary when crossing large streams and lakes. Normally, when water is on the ice it is safe, but when water recedes below the ice cover the strength of the ice drops dramatically. Shorelines and the inlets or outlets of streams should be closely checked so that you do not arrive at the other side only to find that the exit areas are not strong enough to support your vehicles.

3. Movement cross-country may be restricted for 24 to 48 hours in the high latitudes due to the crystallization of snow, as crystallized snow has no load-bearing capacity. In this condition, tracked vehicles easily become high centred and movement is halted. Recovery is complicated because of the lack of firm footing. Although the going may be heavy, the high permafrost level ensures that vehicles normally do not become bogged down in the mud.

4. During the spring period, vehicles should carry a reduced load. If possible, traffic should be permitted only at night when temperatures are below freezing. This will allow engineers time to perform necessary maintenance during the day without interruption. When nights become so warm that the roads will no longer freeze, heavy traffic may turn them into morasses. During the transition time, nothing can be done except minimize traffic.

SUMMER

5. The Arctic and Subarctic regions in summer are characterized by an abundance of open lakes, streams and swamps which impede movement. In the Arctic, movement is much easier, as the many eskers (gravel ridges) provide good travel conditions. In the Arctic islands, medium or heavy tracked vehicles can move on any terrain because of the high permafrost level, except where steep hills or cuttings restrict movement. Hills should be climbed straight up because of the danger of slipping on surface gravel caused by ice at the permafrost level (10–15 cm north of 75 degrees north latitude). Ice on lakes north of 75 degrees N may remain throughout the summer, and although sometimes up to 2 m thick, it may be unsafe due to candling. Candling is a condition where the ice crystals form vertically, and although the ice may be quite thick, it has no horizontal strength and is very unsafe for movement, particularly vehicle movement. Close attention must be paid to this with a thorough ice reconnaissance, and, if necessary, alternate routes must be taken. See Figure 3-4-1 for a photo of candled ice.

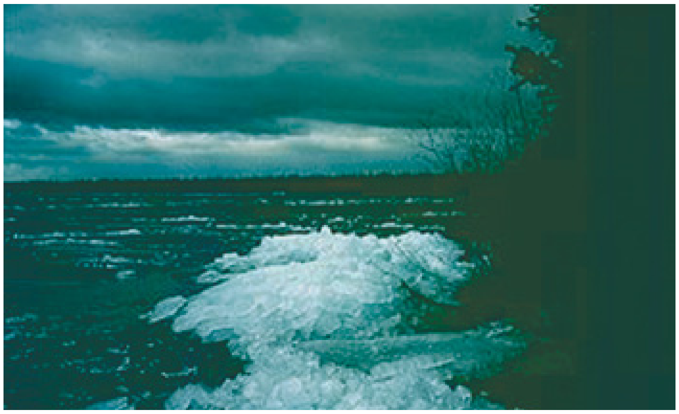

Figure 3-4-1: Candled ice

6. In summer, much of the northern terrain is a soft mud-based marshland or muskeg, or it is a swamp covered with a thin layer of moss and lichens. Once the layer of moss is ruptured, the mud offers no support above the permafrost level. In some areas during the summer, the frost layer thaws to a depth that limits tracked vehicle operation. Floating bogs may also be encountered. These floating bogs are masses of thick vegetation (alive, or dead and rotting) that float on bodies of water. They will usually support a person but will not support a vehicle. If a floating bog is suspected, a long pole should be used to determine where it starts. Floating bogs must be avoided through careful reconnaissance and route selection. In some areas, muskeg is interspaced with large glacial boulders just below the surface. Damage to suspension systems and tracks is highly probable during operations in such terrain. All tracked vehicles should have their normal rubber track pads, trim vans and skirting mounted. When it becomes necessary to cross open muskeg, vehicles should make their own tracks, and no abrupt turns should be attempted.

Figure 3-4-2: Tundra in the summer, Yukon

7. During summer operations in the Arctic regions in particular, attention must be given to inspection of sprockets and road wheels. Small limestone rocks approximately 10 cm by 5 cm will become locked by centrifugal force between rubber wheels, and the resulting friction can cause fires. This is encountered when crossing loose gravel areas which have a high surface water content. Under these conditions the vehicles should halt, then reverse one to two metres before continuing to move.

8. Recovery in muskeg is exceptionally difficult because vehicles belly down and tracks do not grip the surface. It is frequently necessary to winch the vehicle to a spot where the muskeg is solid enough for the tracks to grip the surface before recovery can be completed. Recovery will often require two vehicles.

FALL FREEZE-UP

9. In some northern areas, heavy rainfalls complicate military movement. Unpaved roads are thawed during the summer, and the fall rains create deep mud. Ruts made in the mud during the day will freeze on cold nights and further hamper movement. Vehicles may also break through thinly frozen crusts. Cross-country movement is difficult because long grasses and leaves on bushes tend to hide steep-banked ditches and streams. Once vehicles become mired, recovery is difficult and time-consuming. Warm-water springs cause thin ice, which can be a hazard when covered by snow. Generally, these conditions occur during the first three weeks of the season.

10. During the later part of the fall freeze-up period, mobility is greatly increased, but thorough route planning and reconnaissance should be carried out.

CHAPTER 4
FIRE SUPPORT

SECTION 1
INTRODUCTION

GENERAL

1. The effect of the environment on all forms of fire support is a major consideration in cold weather operations. Extreme cold temperatures will reduce the range of some weapons, and rates of fire can be considerably altered. Times in and out of action are increased for all indirect-fire weapons. Breakage and malfunctions increase in frequency, reducing the number of weapons available for the task. Techniques and deployment drills must be adjusted to counter the effects of cold weather. This includes siting of weapons, use of alternate positions and fire-directing procedures. The greater range of some modern indirect-fire weapons (long-range precision rockets) will allow supporting fire to be provided at significantly longer ranges from the supported troops, which may ease ammunition supply issues.

ICE FOG

2. A problem common to all weapons fired at low temperature is the formation of ice fog over the weapon position. This fog has the double effect of obscuring the crew’s vision and giving away the position to the enemy. Ice fog cannot be prevented. Alternate positions and offset observers are required to control the fire when the target is obscured.

NIGHT OBSERVATION DEVICES

3. Night observation devices can be very effective in cold conditions. The higher difference in temperature between targets and the snow-covered background typically show up well on TI sights. However, heavy environmental clothing may significantly reduce the ability to detect personnel due to its insulation properties. Image intensification devices are enhanced by the large amounts of snow cover, which reflects and increases ambient light (whether from the moon or stars or human-generated). These sights suffer from the same disadvantages of any other equipment: the cold affects parts and reduces the effectiveness of batteries and other electrical and electronic components. Other limitations include the following:

a. restrictions on visibility due to fog and blowing snow;

b. shorter life of batteries, and difficulty in keeping spare batteries warm;

c. additional bulk and weight to carry; and

d. the need to keep the large objective lens free of ice, snow and condensation.

USE OF SMOKE

4. Generally, cold weather provides ideal meteorological conditions for the use of smoke for deception and screening. Smoke shells are very effective on hard-packed snow. However, loose snow will allow smoke shells to bury themselves and their fillers without creating significant smoke. Generally artillery and mortar smoke rounds are more effective than base-eject shells, because the canister from a base-eject shell can bury itself in snow. Smoke pots and smoke grenades are very effective, but their heat may cause them to sink into the snow. To prevent sinking, smoke pots should be placed on solid platforms such as boards or pieces of brush, and grenades should have a board or a thick stick taped to them.

SECTION 2
DIRECT FIRE WEAPONS

ANTI-PERSONNEL WEAPONS

1. All weapons will have a high rate of malfunction and breakage in extreme cold weather conditions. A greater number of parts will fail, therefore commanders must ensure that sufficient repair parts are carried. Personnel must be trained to quickly identify breakages and must be taught basic repair procedures. To ensure that weapons will function, great care must be taken to ensure that ice does not form on moving parts.

ANTI-ARMOUR WEAPONS

2. All weapons suffer from higher breakage rates in extreme cold conditions. Some propellants burn more slowly and less completely in extreme cold, which can affect range and accuracy. Certain weapons cannot be used safely in extreme conditions. Specific publications for each weapon should be consulted before using the weapon in conditions of extreme cold. For example, M-72 rockets should not be used at temperatures below -40 degrees Celsius. Many anti-armour weapons also have sophisticated aiming systems, and these can be greatly affected by the cold as well. Some weapon systems such as tanks may have fewer problems because they have heated turrets. Wire-guided anti-tank missile systems can have significant problems as control wires become brittle with the cold. Batteries and other electrical components can also suffer from the cold, and battery life is reduced.

3. Ice fog formation, blowing snow and snow blown up by muzzle and backblast will reduce visibility while making it harder to conceal weapon systems once they have been fired. This obscuration will also occur in the target area when ice fog forms and snow is blown up by explosions. This makes first-round hits very important. Training and experience in observing the fall of shot in winter conditions is vital. Once obscuration from the firing weapon occurs, it may be necessary to correct fire from another weapon or observation position. In AFVs, due to sighting systems and the elevated position, the crew commander’s position on a different vehicle may be the best place to control fire from, although it should be used as a last resort. Proper training and practice in observing the fall of shot in winter conditions will help.

4. Extreme cold decreases muzzle velocity, which in turn decreases accuracy and range. Cold ammunition has different ballistic properties than warm ammunition. Cold weather firing tables must be provided for all types of ammunition. In the absence of this information, units must determine data from previous experience and by actually firing in the existing conditions. An immediate initial hit on the ground for observation and correction is of great importance, but must be balanced against the importance of a first-round hit. Extreme cold weather will also decrease the rate of fire due to handling problems.

5. There are difficulties in handling ammunition. Even unpacking ammunition is difficult in cold weather and while wearing heavy environmental clothing. Ammunition can freeze in the packing cases and may have to be cut free. Cold ammunition placed in a warm vehicle may develop frost crystals, which can make the ammunition slippery to handle and difficult to actually load. Ammunition racks are more difficult to operate while wearing heavy gloves and mittens.

AIR DEFENCE WEAPONS

6. Air defence weapons are typically quite complicated, involving electronics for detection and communications, complicated fusing and rapid traversing mechanisms, all of which are vulnerable to conditions of extreme cold. Power sources must be maintained, and maintenance and spare parts must be planned for. Airfields and logistics sites are both very important in cold weather operations, and they are also harder to hide. They may require a higher priority for limited air defence assets.

SECTION 3
INDIRECT-FIRE WEAPONS

GENERAL

1. Due to the smothering effect of deep snow, mud, and muskeg on exploding rounds, artillery and mortars may be less effective in some conditions of extreme cold at certain times of the year. However, explosions on rock, gravel, or ice can create much greater fragmentation than usual. The difficulty of ammunition resupply must also be taken into account, and having a good supply of ammunition for a few weapons is better than having many weapons with an inadequate supply of ammunition.

2. The use of aircraft and helicopters for observation of targets should be exploited whenever possible. Such aircraft can also assist in establishment of communication relays, reconnaissance of routes and positions, identification of objectives, and orientation of ground troops. Due to a lack of transport infrastructure, particularly in areas of extreme cold, medium helicopters will be vital for moving guns and artillery ammunition around the battle space.

3. In offensive operations, due to the slowness of assaulting troops and vehicles moving in deep snow, it may be necessary to provide fire support for longer periods of time as assaulting forces move onto their objectives. Firing must be closely controlled, and assaulting forces may also have to “lean into the barrage,” even to the point of risking casualties from following supportive fire too closely. If fire is not very closely followed, the time gap between lifting the fire and the assaulting troops actually reaching the objective may give defenders time to recover from the shock of the fire, man their defences and repulse the attack with significant casualties.

4. Due to the increased variation of cold weather meteorological conditions from standard conditions, indirect fire calculated using standard met data will be far less accurate. For accurate fire, meteorological readings will have to be taken and applied more frequently. The standard fire-control computers will be able to compensate for the low temperatures.

FIRE-CONTROL PROCEDURES

5. Normal fire-control procedures and techniques are valid during northern operations. GPS systems will be used for initial surveys, and this will generally ensure speed into action and excellent initial accuracy of the fire. However, if for any reason (jamming, poor satellite signal, etc) the GPS does not function, then the following techniques may have to be used, which will adversely affect speed and accuracy. Guns may have to establish a common/arbitrary grid to include all fire units and observers (including other arms observers). A common grid can be achieved by either employing normal survey methods or expedient measures such as airburst fixation coupled with the use of gyro-orienters, or orientation by astronomical observation. The determination of registration correction data can best be accomplished by visual cross-observation, either ground or air-burst.

6. During the long periods of darkness in the winter, aiming-post lights are continually required. Modern lithium batteries, if cared for and used properly, will provide sufficient power for this.

7. Extreme cold will affect the ballistic characteristics of all weapons and must be taken into account. Special cold weather firing tables may have to be used. Prior extreme cold weather experience and practice will be enormously helpful.

MOVEMENT

8. Successful movement is accomplished as a result of careful, detailed, comprehensive route recce. During winter operations, most movement will be conducted under cover of darkness. The weight of the guns may necessitate the use of specialized equipment, which may include sleds or skis and vehicles with dozer blades to prepare routes. In Summer, Spring and Fall, additional engineer resources may be necessary to ensure mobility. At all times, medium helicopters will be a huge asset for moving guns and ammunition around the battle space. However, there will never be enough helicopters to carry out all the desired work, and alternative movement plans will often be necessary. As in all military operations, helicopters in cold weather operations are extremely vulnerable to even unsophisticated anti-aircraft fire, and this must be taken into account with route planning. Adverse weather conditions may also limit or cancel planned helicopter operations. Overall, the movement and deployment of all indirect fire assets simply takes longer in winter conditions, and this must be taken into account by staffs when planning operations in cold conditions.

9. Prime movers should be tracked if at all possible. Tracked vehicles must have grousers, and wheeled vehicles must be equipped with chains.

GUN AND BASE-PLATE POSITIONS

10. Positions should be chosen primarily for tactical reasons. However, in cold weather, even more consideration than normal must be given to locations affording protection from the elements and allowing ease of resupply. Positions should be prepared prior to occupation whenever possible, and should be built up using snow, rocks, bush or whatever material is available. Extreme difficulty in digging in will usually be encountered. Effective and continuous occupation and operation requires warming tents or preferably splinter-proof shelters within, or very close to, the firing position. Protection and all-round security must never be neglected.

11. Camouflage is difficult but not impossible. Maximum use should be made of terrain features, camouflage nets, paints and natural materials such as vegetation. Weapons must be dispersed and camouflage discipline constantly enforced. If possible, weapons should move periodically, and this may be necessary due to the formation of ice fog during firing.

12. No current Canadian gun has skis for use in snowy conditions. Platforms must be prepared in order to fire from deep snow, and prime movers may have difficulty manoeuvring off prepared roads and trails. Mortars direct virtually all of their recoil downwards and must be fired from firm positions. Deep snow, however hard-packed, will not provide a stable platform without significant reinforcing. Gun platforms must be dug in and engineer support may be required.

OBSERVATION

13. During the winter period, good observation will be restricted due to long periods of darkness. Observation will also be limited by periods of fog, ice fog, snowstorms, blowing snow, and whiteouts and greyouts. Snow cover will reduce depth perception and obscure ground features and landmarks. Amber filters for observation instruments are required to improve visibility and reduce eyestrain. Personnel operating these instruments should be relieved frequently, which will demand more trained observers. Practice and experience in conditions of this sort is highly beneficial.

14. Ground burst of rounds is difficult to observe against snow-covered terrain and swampy ground, particularly in poor light conditions. Airburst HE, WP and coloured smoke may be required. This should be practised prior to deployment. In some conditions delay may be effective if it kicks up significant debris, as long as it can be clearly seen against the background.

15. Observers and controllers must be able to move with their supported element. If movement is on skis or snowshoes, then the weight of batteries and radios may have to be distributed throughout the supported element to allow the observers to keep up.

AMMUNITION

16. Extreme cold temperatures can cause fuses to malfunction, but modern electronic fuses will usually function at very low temperatures (down to at least -40 degrees Celsius). Typically, modern fuses can be set for proximity, point detonating and delay. Due to the nature of the ground and snow cover, the most common fuse setting in extreme cold conditions should be proximity, as deep snow, muskeg, and boggy areas will reduce the effect of surface bursts by as much as 80 per cent. Moisture-control measures must be taken at all ammunition supply points to minimize fuse malfunctioning due to frost or ice particles. Most HE rounds have a minimum operating temperature of -40 degrees Celsius and a minimum storage temperature of -62 degrees Celsius, and illumination projectiles have a minimum operating and storage temperature of -53.8 degrees Celsius.

17. Carrier munitions are adversely affected by deep snow. The canisters from base-ejection shells may be covered in snow. White phosphorous rounds may fail to ignite if buried in deep snow, but they may ignite once the snow melts and exposes them in the spring.

ARTILLERY SURVEY

18. Artillery and mortar positions are normally set up using GPS, the temperature range of which is +70 degrees Celsius to -32 degrees Celsius. Modern GPSs equipped with the Cold Weather Battery Pack (CWBP) can be used at temperatures below -32 degrees Celsius. If the GPS system is weak, jammed or unreadable for any reason, indirect-fire assets will survey in using triangulation with electronic measuring devices. Grid bearings may be determined by astronomic observation or by using a gyroscopic direction-determining instrument. It may be necessary to use observation to correct the fall of shot from estimated positions.

LONG-RANGE PRECISION FIRE (ROCKETS)

19. Long-range fire is usually provided by rocket systems. Long-range precision fire, whether provided by Canadian or Allied fire units, is potentially a huge force multiplier. Fire support can be provided at ranges of 300 km or more. This allows for concentrating of the weapons, which can greatly reduce the logistical problems of supplying isolated gun positions. However, the limited numbers of long-range weapons available may reduce the availability of fire units to support non-priority situations, and at extreme range, the time of flight to get the warhead on target may become significant. As with all indirect fire, extreme cold may also affect fuses, payload and propellants, and may result in shorter maximum ranges, smaller effects on the target and less-than-optimum fuse functioning. Rocket fuses and propellants typically function well within a temperature range of +50 degrees Celsius to -40 degrees Celsius.

MORTARS

20. Extreme cold temperatures will cause an increase in the breakage of firing pins, base plates and other parts. Ground-mounted mortars should have their base plates cushioned with sandbags, small branches or bushes, evergreen boughs, small logs or similar types of material which will provide a suitable cushion. Precautions must be taken to prevent the base plates from becoming frozen to the ground, as the time required to free the base plates and move them to new firing positions might be significant. Mortar base plates should be periodically unstuck when not firing, but it must be taken into account that this can affect the weapon's accuracy.

21. In summer or in periods of winter thaw, it may also be necessary to build up or reinforce base-plate positions with wood, sandbags, gravel or other materials in order to provide a firm base position to fire from.

SECTION 4
OFFENSIVE AIR SUPPORT WEAPONS

GENERAL

1. The effects of the environment on modern air-delivered weapons are minimal. Modern GPSs and other navigation systems make actual navigation far more precise than in the past, regardless of the weather, and precision-guided weapons are extremely accurate. As with artillery and rocket projectiles, the actual effect of the munitions may be reduced due to the damping effect of deep snow or muskeg, or enhanced by rock and frozen ice. Air-delivered munitions may require proximity-type fuses. Weather and other conditions may make it harder to locate targets, but modern navigation equipment will greatly reduce those effects. Due to the huge distances, aerial tanking resources will be very important to sustain air operations, and aircraft of all types should be fitted with aerial tanking receptacles/ equipment if possible.

SEAD

2. In order for aircraft (including helicopters) to be utilized to their full potential, SEAD must be planned for in all operations. Electronic warfare (EW) operations and direct attacks on enemy anti-aircraft weapons and air defence radars will yield significant benefits. Similarly, enemy efforts to conduct SEAD must be countered. Long-range AD systems must also be taken into account for their ability to influence air operations at significant distances from the actual AD emplacements.

CLOSE AIR SUPPORT OPERATIONS

3. Close air support (CAS) will be used to provide fire as in temperate areas. CAS aircraft can be staged out of distant bases without stressing the forward logistics system, so that may be preferable to basing fighters close to the front. However, while the relatively high speed of modern fighters will allow staging from distant areas, there is a time penalty due to transit times. Careful coordination of CAS assets will be required to ensure that units get the support they need when they need it. Long-range CAS operations will also require significant tanker support. Modern precision-guided munitions will allow individual CAS sorties to significantly affect the battle.

AIR INTERDICTION OPERATIONS

4. As supply will be vital for any operation conducted in conditions of extreme cold, air interdiction may be used primarily to attack enemy supply lines. Large-scale operations of this sort can be conducted from distant bases if tanking assets are available. Although having significant CAS sorties flown against enemy front-line forces in view of our own forces is good for morale, due to the nature of extreme cold operations, long-range interdiction of the enemy supply and support echelons would likely yield better results in the long run. Some thought must also be given to providing friendly supply lines with protection from enemy air interdiction using either fighters or ground-based air defence assets.

COUNTER AIR OPERATIONS

5. An adversary will attempt to carry out the same kinds of air operations as do Canadian and allied air forces. To reduce the effect of enemy air operations, Allied air forces will conduct counter air operations, namely combat air patrols (CAP) and interdiction of enemy air bases. This may reduce the number of aircraft available for CAS for the ground operations, and hence the necessity of balancing out these conflicting requirements. This is obviously not a factor when conducting operations against an asymmetric adversary who lacks a viable air force.

ATTACK AVIATION

6. Attack helicopters, when available, will be a highly effective, flexible and mobile firepower source. However, their limited range and speed means that they must be based well forward, with the resultant maintenance and logistics issues associated with operations in extreme cold. Given the sophistication of modern fire-control systems and sensors on modern helicopters, heated and sheltered maintenance facilities will likely have to be set up for them relatively near the operational areas. Adverse weather could also severely constrain attack helicopter operations.

USE OF UNMANNED AERIAL VEHICLES (UAV)

7. The use of UAVs, both strategic and tactical, for surveillance will be invaluable. Very small “micro”-sized UAVs will likely be used as low as sub-unit level to build the picture of the battlefield. Armed UAVs, whether Canadian or allied, may be available to provide fire. The ability to fly UAVs from bases located far from actual battlefields in all (or at least most) weathers will reduce congestion, maintenance and supply issues at airbases closer to the cold weather front. Chapter 6 discusses the use of UAVs in greater detail, including the issue of ground control. There will be requirements to coordinate and control flight paths of all but the micro UAVs. In high-latitude areas, there can be issues with the use of long-range UAVs, as they are usually controlled by means of satellites in geosynchronous orbits, which, depending on the actual latitude, may no longer have line of sight to the UAV.

GUNSHIPS

8. The US Air Force has fixed-wing gunships (based on transport airframes) that may be available for operations in support of Canadian operations in cold weather regions around the world. They feature extremely capable sensors and significant firepower, combined with a long loiter time. Their impact will be greatest when conducting low-intensity operations, as they are unlikely to survive in the face of a sophisticated air defence system.

SECTION 5
MESSAGING

GENERAL

1. Messaging involves techniques in support of strategic communications used by a CF organization to ensure that the message it wants to convey is delivered to the correct target audiences. These audiences can include adversary groups, own forces, the local population (allied or otherwise), the Canadian population as a whole and the international audience. Various techniques can be used to put out the specific messages, including radio broadcasts. Given the generally harsh conditions and isolated organizations involved in cold weather operations, a carefully executed messaging plan can have a dramatic impact on all players in the operation. A messaging plan should be prepared and executed under central control to ensure consistent messages. This could include (but is not limited to) public affairs, psychological operations (PSYOPS) and civil–military cooperation (CIMIC) elements. However, for the plan to be really effective, all elements of the deployed force must be aware of the intended message(s) and those messages must be reinforced at every opportunity by all means available. Possibly the single most powerful means of messaging available is the conversation and actions of individual Canadian Forces members.[2]

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[2] Messaging is sometimes referred to as “non-lethal” or “non-kinetic” means.

CHAPTER 5
ENGINEERING

SECTION 1
INTRODUCTION

GENERAL

1. In all cold weather operations, engineers retain their assigned role and functions. However, the harsh environment and lack of ordinary infrastructure will likely mean that significantly more engineer assets will be required in order to conduct any operation in extreme cold conditions, including large-scale training exercises. This is particularly true of specialized engineer equipment. For example, hydraulic-powered equipment will be slower and less powerful, as the cold affects the hydraulic fluid. Therefore, most engineering tasks will take longer to complete in the extreme cold than in temperate regions. Due to these time constraints, many engineer tasks will have to be done by other elements under the direct supervision of engineer advisors. In some circumstances, combat troops may have to be utilized for these tasks.

2. Environmental regulations in most of the Far North, both in Canada and in other countries, can be fairly restrictive. Except in an emergency, environmental regulations must be followed, and they must be taken into account when activities are being planned.

3. Seek guidance from the host nation on up-to-date environmental regulations.

SECTION 2
DEFENCES AND OBSTACLES

FIELD DEFENCES

1. All troops must be capable of constructing field defences and obstacles on snow and frozen ground using any material available. This includes constructing obstacles with wire and timber, snow and ice, available trees and brush. Troops must also be capable of deploying anti-tank and command-detonated anti-personnel mines under winter conditions. Obstacle construction will include icing riverbanks and lakeshores and cutting holes in the ice of rivers and lakes.

2. Explosives can be very effective in cold temperatures, but cold can significantly affect the actual deployment of explosives. Normally, gloves should not be worn while handling explosives, but without gloves it will be almost impossible to handle explosives safely. Thin leather gloves will provide some protection from the cold and still allow the wearer sufficient dexterity to handle the explosives. Plastic explosive (C-4) becomes very hard and brittle in extreme cold, making it very difficult to insert detonators into the charge, unless this is done in a warm shelter. The reduced plasticity also makes it difficult to attach the explosives to the structure or ground that you wish to work on. The actual explosion of the detonator can also shatter the plastic explosive at temperatures of -40 degrees Celsius rather than detonating it. TNT is a far superior explosive in cold temperatures because the detonator is built into the blocks. The detonation cord and the time fuse become stiff with cold and can break if manipulated outside a warm shelter. Charge calculations may vary from standard data, and this must be taken into account. Condensation can be mostly avoided by taping over the ends of det cord, blasting caps and igniters. Static electricity easily develops under cold, dry conditions, so non-electrical detonation techniques are much preferred over electrical ones. Military dynamite or TNT blocks can be used to dig hasty fighting or gun positions. Given the nature of the terrain, most defences will be built up rather than dug in. Whenever possible, local materials should be used, but it must be recognized that there are very limited materials available in some areas (for example, above the treeline), and this shortfall can only be made up with significant logistical effort.

3. Military dynamite and TNT blocks are not normally in the inventory of the CF. During planning for operations in cold weather conditions, these items will have to be ordered from non-military sources. Units that routinely use explosives in conditions of extreme cold should ensure that they have sources for these explosives and have personnel qualified to use them.

MINES AND MINE WARFARE

4. With the exception of the command-detonated type, anti-personnel mines are illegal for the CF to use. Anti-tank mines can be used effectively if there is an armoured threat, or if the enemy has large numbers of vehicles of any type available. During the winter, mine bodies should be painted white. To ensure activation, anti-tank mines should be placed on a firm bearing surface, such as large rocks, ice, timber or even thick frozen cardboard. Any work with mines becomes quite time-consuming in extreme cold conditions, and any work that can be done safely in shelters should be done there. Given the normal difficulties of navigation, great care must be taken in registering the minefield.

5. Anti-tank mines are not always effective in deep snow. Additional snowfalls after laying the mines may cause them to be “bridged over,” resulting in the normal pressure from a vehicle being insufficient to set off mines buried in deep snow. If water or moisture penetrates the fuses, this may also prevent detonation. Conversely, it is possible for mines to simply detonate themselves due to pressures created by the freeze–thaw cycle. In addition, it is very difficult to safely lift mines that have been frozen to the ground, and if ground/snow melting devices cannot be used, the mines may have to be destroyed in place.

IEDS AND BOOBYTRAPS

6. Victim-activated and command-detonation devices can be used in cold weather, although there are issues with long-term electronic timers and ignition devices that require batteries in order to work. High levels of static electricity in windy, cold and dry conditions can make electronic detonation problematic. Very deep snow may also affect the initiation sequence of some devices or muffle the explosion when it goes off. Standard counter-IED TTPs are applicable in cold conditions.

SECTION 3
MAINTAINING MOBILITY

ROADS AND TRACKS

1. Since communications routes in most cold weather areas are generally limited to primitive roads and trail networks, and the more extensive road networks that exist in less isolated areas may be blocked by large snowfalls, a major engineering effort to assure movement and resupply may be necessary. Poor maps and navigation aids, a lack of natural materials such as gravel, wood, etc, and the climatic extremes can increase the personnel and equipment requirement for construction and maintenance. In summer, the numerous streams, swamps and lakes necessitate increased quantities of crossing equipment. The supporting engineers on an operation in an isolated area must have survey training and equipment in order to lay out roads and tracks. It may be necessary to lay trackway or matting in order to support heavy vehicles over deep snow in winter, or permafrost/tundra areas in late spring and summer.

2. Route-selection criteria vary by season. Unless a major road-building operation is mounted, it is quite possible that two sets of “seasonal roads” might be necessary in the regions of extreme cold. In summer, routes are selected for bearing strength; winter routes are selected for gradient and snow depth. In areas of tundra, the snowdrift pattern is a major factor. Areas subject to drifting should be avoided, or snow fences should be used. All weeds, small shrubs and bushes, and rocks must be removed from the prevailing upwind side of the road to reduce blowing snow accumulation on the road. Early snowfall should be removed to allow frost to penetrate into sub-grade faster. Roads should be developed and maintained by straightening sharp curves, constantly filling in holes, draining surface water and the like. Engineer equipment must be available along the length of the route to allow for this maintenance and for continual snow removal. The Northwest Territories in particular have significant experience building “ice roads” on lakes, rivers and streams, and these techniques could be adapted to build military roads in the depths of winter. In more populated and developed areas, more extensive road networks will exist, but either way, snow removal may be a massive and continuous undertaking, consuming large amounts of scarce engineering resources.

3. Frequently, winter traffic effects on non-permanent snow roads will result in loose snow and soil mixtures which cannot be compacted. Sometimes this unstable material may have to be removed from the surface to restore traction. If and when temperatures get sufficiently low, this condition may be corrected by mixing vegetation with the snow, adding water and restoring the road’s stability by freezing. It may be necessary to routinely groom road surfaces to provide traction. Harrows can be towed behind tracked vehicles in order to texture and stabilize the roadway.

ICE ROADS

4. In some cold regions that lack a comprehensive transportation network, the best sites for winter routes may be found along frozen waterways. They have an advantage over normal roads in that they are relatively easy to prepare, are flat, and require only snow removal and possible strengthening of the ice in places, particularly where the roads enter or leave the ice surfaces. Additional requirements are water pumps to provide water for flooding and shaping, and some engineer preparation of the entrance and exit points to the road. Typically, the longer ice roads use lakes and rivers with land portages between them. It may be necessary to build bridges on parts of the portages to cross streams and gullies. In fact, many communities in the NWT are at least partially supplied by heavy transport trucks operating on annually established ice roads.

5. However, there are disadvantages to ice roads. These include a sudden rise or fall in temperature change making the route unusable (warm weather can melt the ice and extreme cold weather can crystallize ice); the effort required to maintain the road; recovery needs, including recovery of any vehicles that break through the ice; and actually having to re-route the road if a vehicle breaks through the ice. Another disadvantage is the impossibility of camouflaging the ice road. These factors make the use of ice roads less practicable in forward areas, but the overall use of ice routes as strategic supply routes or as tactical routes should not be automatically excluded from plans. Careful noting of prevailing and recurring climatic conditions will be necessary, as the effort to build and maintain these roads is significant and, depending on the time of year and location of the road, they may only be useable for very short periods of time (sometimes only a few weeks).

6. Reconnaissance of routes over and across lakes and streams must include detailed reconnaissance of ice conditions throughout the full distance. This reconnaissance may require the use of engineer divers. A critical test is to prove that the ice is supported by water and not held above it at the ice perimeter. This is particularly important on streams and rivers. The ability of the ice to support the heaviest vehicle and the proposed density of vehicles must be proven initially, and the route must then be tested periodically.

7. The strength of ice varies with its structure and temperature. Figure 5-3-1 shows bearing capacity for planning purposes. Note that this table is only a guide; a number of factors can influence the load-bearing capacity. Commanders should seek expert advice before conducting operations on ice. No distance apart has been given for helicopters, as the risk of rotors generating whiteout conditions when helicopters land and take off close to each other is far greater than the risk of ice breaking under the weight of the aircraft.

SERIAL	DESCRIPTION	THICKNESS OF ICE (CM)	DISTANCE APART (M)
1.	Person on foot or skis	5	–
2.	File of people	10	2
3.	LOSV (snowmobile)	10	10
4.	Wheeled tractor	10	15
5.	½-ton vehicle	20	20
6.	¾-ton vehicle	25	20
7.	3-ton truck with load	30	20
8.	10-ton truck with load	35	20
9.	Bulldozer, 5-ton	35	20
10.	Bulldozer, 10-ton	45	25
11.	AFV, 10-ton	35	20
12.	AFV, 25-ton	50	30
13.	MBT, 65-ton	80	50
14.	Utility helicopter	25	–
15.	Medium helicopter	35	–

Figure 5-3-1: A general guide to load-bearing capacity of ice (vehicles)

BRIDGES AND BRIDGING

8. Non-equipment fixed bridges of timber and steel, floating bridges, ferries and equipment bridges are suitable, within limits, for stream crossings. Although bridge construction methods employed in temperate areas are suitable for cold weather regions, special consideration should be given to the following:

a. logistical support including availability of fill;

b. the construction season in terms of ice, permafrost, and snow characteristics; and

c. waterway characteristics in terms of variations at change of seasons (ie, flow during breakup, including the possibility of large ice floes damaging the bridging).

9. Since it will seldom be possible to find ideal crossing locations, the design and construction procedure must minimize the difficulties posed by floods, permafrost and ice.

10. A temporary expedient bridge may be built across a small stream in late summer or fall by using multiple culverts. The culverts may consist of corrugated iron pipe or open-ended fuel drums placed parallel to the flow of the stream and filled over. If these are filled with gravel and/or rocks, the bridge can become semi-permanent. However, these culverts may not be able to handle spring run-off because of ice and snow collected in them. In deep gullies, extra barrels placed above the water line and kept clear of snow before the thaw will increase the probability of survival during spring run-off.

11. Floating bridges may be used during most of the summer and fall, but their reliability is affected by water levels and current velocities.

FERRIES

12. The use of ferries and pontoon rafts for stream, river and lake crossings is a possibility that should not be overlooked. Ferry and raft operations during the summer are not difficult. If certain steps are taken, they may also be employed during the fall freeze-up, or during the period between ice break-up and the absence of ice or with intermittent freezing in late spring. During these periods, a ferry or pontoon raft can be used in place of a floating bridge to reduce the possibility of damage to a large amount of floating bridge equipment. Continual breaking of the ice and agitation of the water by a small reinforced powerboat or an outboard motor mounted on boards implanted in the ice can keep a ferry channel open for a considerable period during freeze-up. Air bubbles created by an air pump connected to a large-gauge hose with holes along its length (a “bubbler system”) may be sufficient to keep a channel open for much of the winter. Regular passage of a ferry on a pontoon raft will also serve to keep the channel open. It may be necessary to build an upstream barrier on rivers and streams with currents in order to protect them from drifting ice.

FORDS

13. Fording streams in cold weather is generally more difficult than in temperate zones. The basic considerations and practices are the same, but several additional factors must be considered. Low temperatures and ice conditions, especially in the stream bed during the spring thaw and the fall

freeze-up, severely reduce traction. During the winter, although ice crossings are common, the fording of some streams and rivers may still be necessary. It may be necessary to build a barrier upstream to protect personnel from drifting ice and a barrier downstream to provide a safety net for personnel.

14. In summer, the variations in stream velocity and depth are important considerations, particularly in streams or rivers from glacial or ice cap areas. Fording of such streams may be feasible only during certain periods of the day when the volume and velocity of the water are at a minimum. Traffic control is necessary to prevent the use of the ford at unfavourable times and to provide assistance when difficulties arise during actual crossing of equipment and personnel.

15. If permafrost is present in streams and riverbanks, the preparation of approaches is difficult. If the banks are high and steep, approaches should not be cut down to the proper grade. Ramps from the bank to the stream bottom may be necessary; they can be used when the height of the bank is not too great. Care should be taken to minimize disturbance of the ground surface when placing them. If permafrost is exposed during preparation of the approach slopes, some expedient type of paving may have to be laid so that personnel and equipment can pass over the exposed area. The rule is to always build up from the surface/permafrost rather than digging into it. It may be necessary to construct ramps or even floating piers so that permafrost can be crossed.

16. Fording of streams in the winter should be avoided where possible because of the difficulties encountered in actual crossing and the effects of water on equipment when the ambient temperatures are very low. Some streams, particularly those flowing in broad flood plains in which valley icing occurs have open channels that continuously shift about the valley during the entire winter. Valley ice is treacherous because the shifting stream can leave unsupported sheets of ice that even relatively light equipment can break through. Once equipment breaks through the ice it is very difficult to recover. The sides of open-water channels are frequently steep and the water is deep. Passage, even by heavy tractor equipment, is hazardous. If such fording is necessary, the route must be well marked, all unsupported ice should be removed, and the route constantly rechecked, preferably after each vehicle. Continuous reconnaissance should be maintained upstream from the ford to determine probable shifts in the water channel. The position of the active stream channel can sometimes be controlled by damming or diverting the stream. The whole channel should be kept clear to a point well below the ford.

17. Only experienced drivers should operate vehicles crossing fords in winter. Before starting across, the vehicle must be in the lowest gear necessary to complete the crossing. In low temperatures, wet brakes can freeze and immobilize a vehicle in only a few seconds. It is important to avoid momentarily stopping a vehicle when shifting in low gear ranges in extreme cold. After vehicles have crossed an open ford under conditions of extreme cold, the wheels, rollers, engine, brakes and clutch should be warmed and dried out in a heated shelter if possible. Given the lack of infrastructure, this will seldom be possible, so vehicles must be kept moving at slow speeds until parts dry out.

18. When dismounted troops have to ford streams and small rivers, it may be necessary or at least desirable for personnel to remove all their equipment and clothing before crossing, and then dress again on the far bank to prevent the clothing and equipment from freezing solid. It may be necessary to provide heated shelters on both banks to facilitate the crossing.

SECTION 4
CONSTRUCTION OF AIRFIELDS

GENERAL

1. Because of the probable reliance on aircraft, particularly helicopters, there may be insufficient existing airfields, airstrips, and helicopter landing zones (LZ) in the desired locations, and some facilities may have to be built for the operation. Construction problems can be minimized by careful consideration of the special conditions in the proposed locations. Sites should be selected in the following order of preference:

   a. existing air facilities (expansion is likely easier than construction of totally new facilities);

   b. known natural landing sites;

   c. hard ground locations suitable for construction of air facilities; and

   d. ice and snow areas suitable for construction of air facilities (may only be seasonal).

CONSTRUCTION SITE CRITERIA

2. When construction is necessary, the site must be selected according to the following criteria (in addition to the normal requirements for site selection in temperate zone construction):

   a. Airstrips should not be built immediately beside settlements or large bases, as the heat generated by human activity will cause ice and ice fog that will affect flight operations.

   b. Major heat-producing sources at the airfield (vehicle parks, heated buildings, cooking facilities, etc) should be located downhill and downwind of the runway and LZ if possible. This will cause surface ice and ice fog to form away from the runway and interfere much less with traffic.

   c. Check for suitable subgrade soil, ground water, surface ice folds, snow, and surface drainage.

   d. A runway in an area subject to temperatures below -37 degrees Celsius for prolonged periods should be located (other factors permitting) so that surface drainage and ground winds clear the runway of ice fog as quickly as possible.

   e. Storage space for removed snow is vital. At least 25 metres of open space is required on both sides of the runway and taxiways.

   f. Eskers, raised beaches, and natural levees along streams make good airstrips because of their elevation and the abundance of unfrozen gravel and sand which can be used to smooth out irregularities.

RUNWAYS ON SNOW

3. The one type of airfield unique to cold weather operations is one built on ice or snow. The preparation of airfields for fixed-wing aircraft depends on the snow conditions and on the size and type of aircraft that will operate from the airfield. The snow should not be removed, but rather should be mixed up to remove air pockets, then packed down with vehicles and rollers. Hard, wind-packed areas might be suitable for light aircraft with balloon tires or skis without further preparation. The deeper a ski or tire sinks into the snow, the longer the ground run for takeoff. Repeated pulverization followed by compaction will increase the density of the supporting snow structure for aircraft traffic. Runways may be constructed on shorefast ice, ice floes or ice islands by flooding the hollows or filling the hollows with compacted snow to form a smooth, even surface.

4. The following must be considered when preparing runways on snow:

   a. Conduct testing during construction.

   b. Provide markers as give length and height references along the runway to assist the pilot in landings (dark-coloured barrels, poles, trees, etc).

   c. Lighting is important during the long periods of darkness, but batteries are not very useful in extreme cold as they seldom hold a charge for a long period of time. Electric runway lights powered by a generator are preferable. Even flares are superior to battery packs, although they must be replaced frequently, almost for each flight. Depending on the time of year (varying hours of daylight), solar lighting may be used.

RUNWAYS ON ICE

5. Ice is classified into two general types: saltwater and freshwater. Each type presents very different problems. For a given aircraft, a runway on saltwater ice requires double the length and greater thickness than one built on freshwater ice. Freshwater ice is normally smooth and has greater strength than saltwater ice. During spring break-up, use of ice airfields in the early morning hours is highly recommended because after the night freezing, the airfield is in much better condition. When using saltwater-ice runways (ocean ice), variations caused by the tides may have to be taken into account.

6. When aircraft are parked on ice strips or sites, the ice must be checked periodically for deformation. Distance between parked aircraft should be decided upon based on ice type, ice thickness, and aircraft bearing pressure, as well as the perceived need for dispersion for protection from enemy action. When de-icing aircraft, special care must be taken to ensure that the anti-freezing fluids do not contaminate and weaken the ice. De-icing should take place on land, and special precautions must be taken to collect and remove the runoff de-icer fluid.

PREPARATION OF LANDING SITES FOR HELICOPTERS

7. The amount of effort exerted to improve sites will depend on their intended use. Little effort is required on the tundra except in summer conditions, when it may be desirable to stabilize the LZ.

8. In forested areas, trees may have to be cut down to clear landing sites and approaches. Tree stumps must not exceed 30 cm in height, to prevent them from damaging the helicopters. Uprooting the trees completely will create very dusty or muddy conditions during the spring, fall and summer that are not conducive to helicopter operations. It is possible to prepare landing sites on hillsides by blasting a ledge, but the remaining gradient must be considered. The planners must ensure that there is sufficient clearance on the uphill side of the LZ for the helicopter rotors.

PROBLEMS OF HEAVY EQUIPMENT OPERATORS

9. During periods of heavy winds and extreme cold, heavy equipment operators are subject to extremely adverse working conditions. Equipment with cabs for the operator are far easier to use even if unheated, as they will provide some protection from the wind. Windscreens and side windows must be kept clear to enable the operator to see the surroundings. Regardless, it may be necessary to change operators much more frequently. If POL is spilled on clothing, the clothing will lose much of its insulation value; therefore, all operators must have at least two sets of clothing. Protective clothing that repels liquids is significantly better.

10. The effect of the cold on the heavy equipment itself must be taken into account, as brittle metal will break much more easily under pressure. Spares and maintenance issues must be addressed. Once machinery and engines are working and somewhat warm, it may be better to keep them running, despite the much greater fuel consumption.

SECTION 5
WATER SUPPLY

GENERAL

1. Supplying water in bulk is a much greater problem than individual supply, but the operational benefits make it desirable when possible. Melting snow in tents creates excessive moisture and condensation, causing significant icing of tents, clothing and bedding and a greatly increased need for cooking/heating fuel, which often has to be carried in packs by individual soldiers at great cost in effort. Therefore, melting of snow or ice to provide water in large quantities is not recommended. The chief sources of bulk water, in order of efficiency, are

   a. drawing water from rivers and lakes;

   b. melting freshwater ice;

   c. melting snow; and

   d. well drilling (at permanent and semi-permanent installations).

2. When possible, water points on lakes and rivers should be located on the side of the lake where the shoreline will protect the water point from the prevailing wind before it blows across the lake. On that side there is generally clearer water, less drifting snow, and more shelter from the wind for the operators. The actual draw points should be located as far from the shore as possible given camouflage limitations. To cut the required holes in the ice (which can be several metres thick), axes, ice chisels, augers, steam jets and explosives can be used.

3. Large-scale provision of water in extreme cold requires heated shelters in which to operate water purification units. For highly mobile situations, an enclosed, heated, truck-mounted unit can be used to advantage as a mobile water supply. Water supply tents should be situated on the ice directly over the hole through which the water is pumped, or as close as possible to it in order to reduce the likelihood of the water freezing in the intake hose.

TRANSPORTATION OF BULK WATER

4. Tracked vehicles are highly suitable for transporting bulk water in extreme cold conditions, as the vibrations will agitate the water and help prevent freezing. Water cans should only be filled to the ¾-full level, as the movement of the vehicle can then cause the water to slosh around inside the cans and slow the freezing process. As water freezes, it expands. The empty space in the water cans will allow space for this expansion and should prevent the can from rupturing if it does freeze. However, as soon as possible, water cans should be stored in heated shelters. Sled-mounted 250- to 300-gallon water tanks in which heaters have been installed are also satisfactory, but will require significant amounts of fuel. Water can also be transported in frozen plastic bags inside cardboard boxes.

SECTION 6
BASE INSTALLATIONS

AIR PORTABLE MODULES

1. There is a vital requirement for base installations at the airhead or forward base during the early spring, fall and winter periods. Use of air-portable, dismantleable shelters or complete units which have insulated walls will prevent many of the problems of assembling modular units from panels in the field. These units can be used for operations and communications centres, air control, and logistics facilities. Heated maintenance facilities will greatly reduce the time required for even simple maintenance work.

HEATED ACCOMMODATION

2. Heated accommodation must be available at the forward base and should be available at the airhead for the storage of equipment and supplies, particularly those that must be protected from the extreme cold. These include batteries, special ammunition, some rations, medical supplies, and some spare parts. Heated accommodation must be available for medical facilities. Air-portable electric generators should be provided wherever possible, since they significantly reduce the danger of fire and improve the reliability of light and communications equipment. Water, heat and light are the responsibility of the engineers, and all will require special attention.

SEWAGE

3. Sewage disposal is also an engineer responsibility. Since human waste breaks down very slowly even in summer, this can be a significant problem where large numbers of personnel gather. Current sewage facilities in small Canadian Arctic and Subarctic communities cannot accommodate the large increases in waste generated by CF operations. This issue must be formally addressed in the plan. Small-scale operations and exercises in peacetime in the Arctic will almost always require human waste to be packaged and removed to the south for disposal. In emergencies, with permission from the various local and territorial governments, it may be possible to incinerate waste, but that will not be common.

CHAPTER 6
AIR OPERATIONS IN COLD WEATHER

SECTION 1
INTRODUCTION

GENERAL

1. Air operations will be of great importance in cold weather ops. In far northern regions around the world, where infrastructure is lacking, they will be critical, but in any cold weather region or period they will be a significant asset to operations. The ability of aircraft to quickly move large loads of troops and equipment independent of ground transportation systems will be vital, and the use of precision fire from aircraft based far away from the area of operations (AO) will reduce the burden on a stressed logistics system. The use of aircraft for reconnaissance and communications will also be significant.

2. Information on all airfields, airstrips, and emergency strips in the area of operations must be made available to the task force commander and the air commander. Particular attention should be paid to eskers and raised beaches. Many eskers provide emergency landing strips for both light and medium aircraft. In Canada, most eskers run northwest to southeast, directly in line with the prevailing winds. These areas are particularly valuable during summer periods when they are fully drained, and during the fall season before the presence of snowdrifts make them unsafe. During winter periods, if a frozen lead is surrounded by long ridges, it is usually an indication the ice is thick enough to support light aircraft.

WEATHER

3. Weather conditions will influence flight operations in cold conditions. High winds cause blowing snow that will affect aircraft ground operations and may affect flight operations, specifically takeoffs and landings. Modern navigation and flight systems will reduce the impact of weather, but they cannot negate it altogether. Extreme cold conditions will greatly affect aircraft maintenance: unless heated shelters are available, aircraft may have to be withdrawn from the theatre for some maintenance procedures. Even minor maintenance procedures will take significantly longer, and in extreme conditions they may not be possible if shelters are not available.

SECTION 2
FLIGHT OPERATIONS

GENERAL

1. In addition to the weather itself, familiarity with other conditions will reduce much of the danger of operations in cold weather.

PLANNING FACTORS

2. The payload capability of some aircraft may be reduced in cold weather operations due to the added weight caused by ski installations and required survival equipment. For fighters, ordnance may be reduced by the requirement to carry more fuel, but the use of precision munitions may in turn reduce the need for large numbers of munitions. This reduction in payload may also be offset to some degree by the increase in aircraft performance due to favourable air density altitude conditions.

3. Higher fuel consumption caused by longer warm-up and fuel-burning heaters must be considered when planning the use of aircraft in cold weather. Once aircraft engines and systems have been warmed up, they may need to be refuelled again. Once aircraft are operating and warm, it may be better not to shut them down between missions. “Hot” refuelling will require some specific equipment, TTPs and sites, and not all aircraft types may be capable of this. The requirement for de-icing aircraft during cold weather ops must also be taken into account. Forward, austere fields will likely not have proper de-icing facilities, and facilities may have to be improvised. At improvised facilities, for environmental reasons, the run-off de-icer fluid will have to be captured and prevented from contaminating the airfield, at least during peacetime operations. In wartime, or during emergencies, any contaminated ground must be marked and recorded for future cleanup.

4. The climate of the operational area should be studied in detail to determine the probable frequency of poor weather conditions that may limit or preclude flight operations.

AIR SPACE MANAGEMENT/CONTROL

5. Due to the heavy use of aircraft of all types in operations, positive control of airspace is vital. AWACS may be necessary for operations in any area where ground control is difficult or non-existent. If long-range, high-altitude UAVs are being used, they must also be controlled.

NAVIGATION

6. Ground features can be altered or covered up completely in conditions of heavy snow. Navigation aids and careful route planning are vital for success. Additional navigation aids such as beacons may have to be installed.

SAFETY

7. In operations in extreme cold, the main hazards to aircraft operation are blowing snow and strong surface winds during the autumn and winter, and fog during the summer. Blowing snow is a hazard in all operations, but especially in helicopter operations. For this reason, hovering of helicopters should be kept to a minimum. Restricted visibility may be deceptive. Inexperienced pilots may not realize how restricted the visibility is since the shallowness of the layer of blowing snow usually permits good vertical visibility but the horizontal visibility is very poor within the layer.

8. Caution must be exercised during external sling load or hoist operations in snow or dry cold air since static electricity is generated more quickly, and at higher voltages than when operating in conditions of higher humidity. Aircrew must ensure that proper grounding of the aircraft is carried out during take-off and landing procedures and during loading activities. Because of the longer periods of darkness, personnel should receive extensive training in night external loading operations. The extreme cold, the lack of visual horizon, blowing snow, and the fact that use of the aircraft lights causes loss of any visual reference make this work extremely dangerous.

9. Wind-chill factors must be well understood, and all personnel should be keenly aware of the very high chill factors encountered in prop and rotor wash.

10. When operating in mountainous terrain, wind direction and velocity may be determined by observing drifting snow: swirling patterns indicate turbulence.

11. Close attention to detail in all aircraft operations is vital because the environmental conditions place greater stress and strain on personnel and equipment. Such attention will likely reduce the risk of material or mechanical failure in flight. When operating light aircraft from austere improvised airstrips, aircrew must always be prepared for emergencies such as having one ski break through the snow crust, which can result in a dynamic rollover of the aircraft.

SECTION 3
AIRCRAFT MAINTENANCE AND FACILITIES

MAINTENANCE

1. The problems of increased maintenance stem directly from the low temperatures. Special precautions and equipment are necessary to ensure efficient operation of aircraft. Maintenance time may be multiplied by a factor of five in extreme cold. Aircraft mechanics are greatly hampered by heavy winter clothing and gloves. Installation of auxiliary equipment such as winter cowls, oil dilution systems, personnel heaters and covers also add a time factor to normal maintenance operations. Maintenance units will require additional personnel in the airframe sections.

2. Operation of aircraft, particularly helicopters (due to their inherent vibrations) in temperatures below -37 degrees Celsius results in a marked increase in metal fatigue. All metal becomes increasingly brittle as the temperature decreases. This will be evidenced by an increase in the number of skin cracks in areas of high stress. Careful attention must be paid to these areas at all stages of maintenance. Seals and gaskets are a special consideration because of the effect of cold on contraction of metals and certain other materials. It is impractical to attempt any significant maintenance requiring bare hands unless the machine is shielded to some extent and the work area is brought up to at least -17 degrees Celsius or warmer.

3. Thickening of oils and other lubricants at very low temperatures presents problems in operation, particularly starting up. Standard winterization kits should be installed. Oil dilution units may be used, although it is sometimes necessary to drain the oil from the engines at the end of the day’s operations and to heat it prior to replacing it in the engines. To prevent the loss of hydraulic fluids, any seals that are leaking at the end of a warm summer must be replaced before the cold weather returns.

4. The standard portable combustion-type heater, incorporating a blower and flexible hose for application of heat to localized areas, may be used for preheating engines before starting. In addition to preheating before starting, these units may also be employed to heat specific portions of the aircraft so that maintenance personnel can work without gloves. When temperatures remain below freezing, aircraft batteries not in use should be removed from the aircraft and stored in a warm place.

5. Mooring of aircraft is made relatively simple in regions of extreme cold by freezing the mooring line into the snow. Aircraft wheels and skis should be kept on dry surfaces to prevent them from freezing to the ground.

6. Wing and engine covers are essential in northern operations if time involved in removing snow, ice and frost from the aircraft is to be avoided. Covers can also serve as camouflage if coloured appropriately.

FACILITIES

7. In most cold weather areas, hangar space is limited, particularly for larger aircraft. As a result, necessary maintenance may have to wait for the construction of temporary shelters. Temporary over-wing heated shelters can be set up to facilitate general maintenance, including engine or prop replacement, without requiring a full hangar facility. For routine maintenance needs, the aircraft should be withdrawn to more temperate locations where proper facilities exist.

8. When selecting areas for aircraft facilities (servicing and maintenance, arming, loading, etc), it is important to consider the following:

   a. tactical and logistical usefulness;

   b. engineering problems and issues;

   c. protection from the weather; and

   d. supply considerations, especially those of aviation fuel, spares and munitions.

9. Before occupation of the selected site, adequate billeting and working areas, roads, and snow parapets should be prepared. If available, prefabricated buildings greatly lessen the time required to build adequate shelters. However, it must be borne in mind that the same factors that make aircraft maintenance take much longer will also affect the speed at which the camp can be set up. If maintenance personnel are to be exposed to the weather while servicing and repairing aircraft, shelters will be necessary near the work area.

DE-ICING

10. De-icing as conducted at major airports and military airfields in temperate climate zones will be difficult if not impossible at any improvised airport, although major cold weather airports like Iqaluit and Resolute Bay in Canada do have this capability. In peacetime operations, for environmental reasons, when aircraft are de-iced the fluid that drips off the sprayed aircraft must be immediately recaptured. This requirement could be waived in an emergency, but the eventual cleanup would be a significant undertaking. This limited de-icing capability can seriously affect air operations in some weather conditions, and it must be taken into account. In some cases it will be unsafe to conduct air operations without de-icing.

IMPACT OF RUNWAY CONDITIONS

11. There are some factors that affect cold weather runway use. Most runways in cold areas are gravel. In areas of extreme cold, from late fall until very early spring, the frozen runways are firm enough to physically support the heaviest transport aircraft, but if the runways are icy they may not enable them to be used to capacity. In the summer months, braking may not be an issue, but very heavy aircraft may actually break through or bog down into the softer, thawed runways. At some cold weather airfields, factors such as these, more than the actual distance or runway length, may limit the size of aircraft loads. Another limiting factor may be the difficulty in stockpiling aircraft fuel in sufficient amounts for extended high-tempo operations; in winter it will have to be flown in, and summer bulk sea transport will not always have access to the airfields being used.

AVIATION FUEL

12. With aircraft operating out of Arctic airfields, the provision of bulk fuel is always an issue. On extended flights in the North, refuelling becomes a major problem because of the long distances and the inability of surface transport to move fuel to isolated airfields. Typically, bulk fuel is brought in to Canadian Arctic airfields during the summer by ship or barge, although for airfields near the ice roads it is possible to bring some fuel in during the height of winter by tanker truck. However, military operations using a significant number of aircraft and/or sorties will burn through the available fuel at any northern airfield very quickly, unless the operation is planned far in advance, including the pre-positioning of aviation fuel. For any unforeseen and sustained operation, particularly in winter, the CF will have to bring in its own bulk aviation fuel, probably by air. Over shorter distances, aircraft may carry enough fuel for the return flight, at a penalty in cargo carried. A large aircraft may fly in with full fuel tanks and be utilized as a “gas station” in order to fuel smaller aircraft from its fuel tanks.

SECTION 4
CHARACTERISTICS OF AIRCRAFT

GENERAL

1. Aircraft are grouped into classes which typically are based on size, capability and designed use. In some cases, it is not uncommon for aircraft—particularly transports—to be placed in different classes depending on how they are used. For example, many nations use various versions of the C130 Hercules as both a strategic and a tactical airlifter. The various classes and types are discussed below.

LIGHT TRANSPORT AIRCRAFT

2. Light aircraft of the bush-plane type are highly suitable for utility purposes. They are rugged, mechanically reliable and relatively easy to maintain. Being capable of operating with wheels, skis and floats makes them more flexible than most large military or civilian aircraft. Some types have impressive short takeoff and landing (STOL) capabilities. These shortcomings are their relatively small size, range and carrying capacity. Most light aircraft have a single engine, but some types (for example, the Twin Otter) have two. They are generally small enough to fit into existing maintenance facilities in cold regions.

MEDIUM TRANSPORT AIRCRAFT

3. Medium aircraft, as their name suggests, are usually medium-sized. They are generally used for tactical airlift. They typically have payloads ranging from 10 to 20 tons and the range to fly useful loads several thousands of kilometres, which means they can be based for much of the time in more temperate regions where they can be supported by appropriate facilities. Although they require sizable runways, there are a number of runways in the cold regions of the world that can accommodate aircraft of this size.

HEAVY TRANSPORT AIRCRAFT

4. Heavy transport aircraft are massive aircraft that are capable of carrying very heavy and bulky loads, including main battle tanks (MBTs) in some cases. They are also referred to as strategic transports. However, their massive load capabilities cannot always be fully utilized in cold conditions due to runway strength and length. The Canadian Forces can operate its strategic transports out of the larger Arctic airfields such as Alert under some circumstances with some restrictions.

PRECISION-GUIDED PARACHUTE-DROP SYSTEMS

5. Modern military transport aircraft do have the capability to airdrop significant loads (including some smaller vehicles) by GPS-guided parachute systems. In good, predictable weather, these parachute systems can be dropped with a high degree of precision. In good weather with light winds, loads up to 10,000 lbs can be dropped with impressive accuracy, from a significant distance away from the planned drop zone. Accuracy of the drop depends on height and lateral distance to be travelled, combined with very accurate wind forecasts, which must be entered into the controlling computer. These systems may not be able to handle the extreme wind conditions that can sometimes occur in the Far North, and alternative methods of supply may have to be used when predicted winds are high. These systems are expensive and are limited in number, so the systems must be recovered for re-use.

HELICOPTERS

6. Helicopters of all types can be used on cold weather operations. There can be range issues, but helicopters actually perform better in cold, dense air. Even large helicopters can be flown to isolated areas on heavy transports and unloaded there, which will overcome some range issues. Helicopters operating from ships will be useful. Under many circumstances, helicopters may be the only practical way of moving troops and supplies around the AO in a timely fashion, given their ability to land on virtually any flat surface including ice. However, helicopter downwash can blow up snow and create whiteout conditions. When slinging loads, a 40-ft sling extension will allow the aircraft to land clear of the load while it is being hooked up, resulting in far less whiteout and prop wash danger as the helicopter takes off. Helicopters and other vertical takeoff platforms (such as the V-22 Osprey) may be useful for SAR and combat SAR operations in the Far North. Some modern helicopters can be fitted with extra gas tanks, and some can be air-to-air refuelled to increase their range.

FAST AIR

7. Fighter aircraft of Canadian and Allied Air Forces can operate in conditions of extreme cold. Operational ranges can be extended by air-to-air refuelling, by both Canadian and allied tankers. If sufficient tanker support is available, fighters can be based significant distances from the operational areas. By using precision-guided munitions, fighters can carry smaller but still significant munitions loads, and by using tanker support, they can loiter over the battlefield for hours. Enemy logistics dumps and lines of communication will present very important targets for these interdiction efforts and are likely far more lucrative and high-value than destroying a single AFV or infantry position. A downside of basing fighters far from the AO is that it may result in long response times.

TANKERS

8. Suitable aerial tankers can significantly increase the range of all types of aircraft, including helicopters. However, tankers may also be required to transport bulk fuel to remote airfields to support increased operations, particularly in winter when more conventional supply sources cannot be used. CF and Allied tankers will always be in short supply, and careful planning will be required to ensure that sufficient tankers are available to support flight operations when required. Tankers may also be necessary for air operations during times of poor weather to allow aircraft to divert to airfields where the weather is acceptable.

LONG-RANGE PATROL (LRP) AIRCRAFT

9. LRP and LRMP aircraft have the endurance and the sensors to provide long-range surveillance in the cold regions from relatively distant airports. This reduces the maintenance and logistics burden at isolated airfields significantly while providing modern surveillance capabilities. However, airborne surveillance platforms should be cued (possibly by space-based systems) to investigate a fairly small area in great detail, as opposed to providing a superficial overall look at the entire region.

UAVs

10. UAVs do offer some advantages over manned platforms. However, the curvature of the earth at high northern latitudes can cause line-of-sight issues for the ground stations and for geosynchronous satellite control for UAVs, which may have to be overcome with additional ground stations or other means. Once control is assured, the huge endurance of strategic UAVs allows them to be based far from the AO, thus avoiding some logistics and maintenance difficulties. The much smaller tactical and micro UAVs, while lacking the range and endurance of their much larger siblings, do not require the fixed installations and logistics tail. The integrated use of all types of UAVs, properly controlled with the resulting information properly collated and distributed, will contribute enormously to the intelligence picture. One disadvantage in operating UAVs could be the HN government flight restrictions on unmanned systems in what is becoming an increasingly crowded sky. This must be controlled at the highest level.

CHAPTER 7
OPERATIONS – GENERAL

SECTION 1
PLANNING

GENERAL

1. The purpose of the previous chapters is to give commanders and their staffs the general background for operating in conditions of extreme cold. The information and perspective gained can now be applied to actual operations on the battlefield (planning, intelligence, etc). The initial sections will discuss preliminary activities, and then specific operational phases will be addressed.

FACTORS

2. There are a number of additional factors which must be considered when planning an operation in any cold weather region:

a. **Other Government Departments (OGD).** This includes territorial and local governments.

b. **Adversary.** Strength, capability, intentions and actions to date must all be considered.

c. **Terrain and Weather.** The geological location, time of year, and general prevailing atmospheric conditions will all influence an operation significantly.

d. **Access.** How will the forces required reach their objective? Road, overland, sea, air, including type and number of airlift, available airfields, drop zones (DZs) and landing zones (LZs).

e. **Lift Available.** Quantities and types of air, ground and maritime lift available.

f. **Alternative Logistics Plan.** If initial plan cannot be carried out due to weather, etc.

g. **Ground Movement Plan.** How will ground movement be carried out once on the ground (foot, ground vehicle, air, water)?

INTELLIGENCE

3. Intelligence techniques for cold weather operations will be essentially the same as those used in temperate zones. Due to the distances and the limited infrastructure, there will likely be an increased use of long-range strategic reconnaissance aircraft and space platforms to provide timely intelligence. Due to the difficulty in changing arrangements once they are in place, it is vital in cold weather ops to conduct a thorough Intelligence assessment prior to deploying friendly assets.

4. After operations are initiated, some collection means, such as long-range patrols, may be more valuable than usual in obtaining information deep in enemy territory. Vehicle-mounted long-range patrols (including those using light oversnow vehicles (LOSVs)) not only provide information but are a threat to enemy installations and lines of communication. This threat will result in increased security measures that will consume scarce enemy resources and assets. During the seasons that the waterways are open, boat patrols may also be used to gather information. EW assets will likely provide a good source of information about adversary intentions.

5. Unattended ground sensors and ground surveillance radar can be employed during the summer season in the same way that they are used in temperate climates. Their use during the extreme cold of winter may be limited due to battery failure caused by the extreme low temperatures. They may also fail because they are covered in drifting snow. Battery packs and electronic assemblies may be deployed in or below the ice cover of lakes or the ocean, or within the active layer of the permafrost to provide a constant temperature environment (0 degree Celsius to -1.7 degrees Celsius).

6. In northern Canada, local inhabitants, Canadian Rangers, the RCMP, church organizations, OGDs and local civilian pilots will all be important to the intelligence-gathering plan. These sources will have their equivalents in other Arctic regions of the globe, and every effort must be made to build positive relationships with all these sources.

SECTION 2
SECURITY

GENERAL

1. Tactical security measures employed in temperate operations remain essentially the same in cold weather operations. However, due to the long periods of darkness and the tendency of sound to travel long distances in cold air, light and noise discipline is even more critical than normal.

2. Security of airfields and landing strips is of paramount importance in cold weather operations. Enemy air landed or parachute operations are always a possibility, especially in order to capture a landing strip. Commanders should consider the use of a mobile force to counter light airborne operations. This force should be used on the LZ/DZ itself during the actual insertion, but once the enemy leave the area, the mobile force must remain in contact and use harassing attacks and firepower to disrupt the enemy activities until additional forces can be concentrated against the enemy lodgement.

3. Security of lines of communication is difficult due to the distances involved. During periods of darkness and during storms and inclement weather, columns should move closed up with protection vehicles dispersed throughout the column. During clear weather, convoys must remain well dispersed if there is an air threat. In the tundra regions, where possible, the protection vehicles should move out as flank guards in order to protect the column.

4. Communications security must be practised. Proper procedures must be followed and radio traffic kept to a minimum. This will limit the value of intelligence gained by the enemy and reduce the probability of direction finding by enemy patrols.

5. Security of any defensive area can best be achieved with a combination of mobile patrols and standing patrols well out from the position in question.

CAMOUFLAGE

6. Good camouflage discipline will enhance protection. The problem is most acute during winter because of sharp contrasts and because of the creation of ice fog by weapons, engines, etc. Special white clothing and camouflage nets are issued for winter use. Canadian army winter camouflage clothing and nets are infrared (IR) and ultraviolet (UV) wavelength suppressant and provide significant camouflage properties beyond the visual wavelengths. Painting equipment and installations with a predominantly white pattern will contribute greatly to the overall camouflage effect in winter. Proper CF camouflage paints also counteract IR and UV detection systems. Another technique that is effective against visual detection is to soak sheets of white paper in water, then place them on vehicles and installations where they will freeze, forming a white pattern. See Land Force B-GL-364-001/FP-001 and 002 *Camouflage and Concealment* for greater details on winter and northern camouflage techniques.

7. Large installations such as airfields will be difficult to camouflage in winter, and emphasis may have to be placed on deception. Vehicle tracks are very easy to follow in winter and very difficult to conceal. Track discipline and deception must substitute for camouflage, by leading the enemy to dummy hides and positions.

8. The general colour of snow-covered terrain is blue-grey. When snow is disturbed it takes on a flat, white appearance and is easily identified. Camouflage of positions should therefore be based on breaking the outline and leaving rough snow conditions in the front of the position. Blowing snow will level and/or fill in the rough snow conditions and result in a better-camouflaged position. The proper mix of camouflage clothing in the treeline is vital. Above the treeline, or in treeless areas, the use of all-white clothing is essential in winter. In the barrens during winter periods, the grouping of personnel, whether stationary or moving, must be considered. Long, continuous lines of evenly spaced troops are easily observed. Troops should move in small, unevenly spaced groups, making use of the terrain and background. In rocky areas or when moving along eskers, the selection of two or more routes may be preferable. During winter months, the practice of camouflaging personal weapons by means of paint, white adhesive tape, or strips of white cloth breaks the outline and helps conceal troops.

9. The problem with the heavy environmental clothing so necessary for survival in cold conditions is that the ability to protect the body from the environment involves a tradeoff: both vision and hearing can be seriously impaired. The parka hood reduces peripheral vision and, especially in high winds, significantly reduces the wearer’s hearing. The bulky clothing also makes moving more difficult and slower, and it requires the wearer to use more energy to move. These factors, when combined with the requirement for the buddy system as a protection against frostbite, dictate an increased requirement for personnel as guards, sentries, patrols, etc. Individuals may have to be relieved significantly more often than under temperate conditions.

10. Summer presents a different set of problems in cold weather regions. The presence of permafrost in many areas will restrict the amount of digging that can be done, and the defences will have to be built up using peat, rock, etc. Winter camouflage materials will have to be exchanged for summer colours. In the Subarctic, considerable natural vegetation may be available to supplement and enhance issued materials, but that will not be the case in the barrens. Desert camouflage techniques will be necessary in the barren lands and on the Arctic islands. They will include the use of tone-down paint, covers for windshields and other highly reflective objects, use of shadow and broken ground, etc. A two-foot-deep depression or fold in the ground will significantly reduce the silhouette of a vehicle. Again, dispersion and deception will be necessary to supplement camouflage.

11. Camouflage is an individual responsibility at all times. However, a camouflage policy will be provided by the highest tactical headquarters. The policy will include guidelines as to the amount of effort that will be devoted to camouflage, concealment and deception, including engineer assistance. Units and sub-units must adjust their camouflage to blend with their surroundings.

CONCEALMENT

12. On clear days there is much less opportunity for natural concealment in Arctic areas than in temperate or Subarctic areas because of the lack of vegetation. Sightlines are significantly longer than in temperate areas, and complete concealment is difficult if not impossible. Small folds and dips in the ground must be used to help conceal vehicles and infrastructure. The Arctic does have long periods of darkness, fog, snow, blowing snow, whiteouts and greyouts that will help with concealment during parts of the year. In summer, there are long periods with no darkness, which will make concealment even more difficult. In the Subarctic the terrain and vegetation are not significantly different from more southerly areas, and concealment is far less of a problem.

13. Whenever possible, advantage must be taken of the limited natural vegetation for concealment. Snow caves and shelters should be used in lieu of tents when practical. Tents can be dug into the snow to reduce their silhouette. Terrain must be used to best advantage when selecting lines of advance, harbours, etc. The clear air and generally flat terrain will increase the distance over which visual observation is effective. Features such as folds in the ground and river and stream valleys must be utilized whenever possible, but the best cover will be afforded by storms, fog, etc. Since folds will seldom be aligned in the exact direction troops need to travel, extensive training and practice in northern navigation techniques must be undertaken in order to take advantage of the concealment opportunities provided. It will seldom be possible to hide completely, but careful use of the small folds and dips can make a significant difference in the distance at which objects will be seen. This use of ground will work both ways, and special efforts will have to be made to cover gullies, re-entrants, streams, etc with surveillance devices, both manned and unmanned.

IDENTIFICATION

14. Long periods of reduced visibility and the use of white camouflage clothing over bulky environmental clothing under snow conditions make combat identification difficult. Increased vigilance is necessary on the part of all ranks. Unit standing operating procedures (SOP) will provide directions on combat identification, which must be strictly followed to prevent incidents of fratricide. Some identification equipment may not work well in extreme cold, particularly if it relies on batteries, and the long periods of darkness must be taken into account. Digital command and control (C2) systems will provide additional positive identification for friendly elements, but they should not be totally relied on.

DECEPTION

15. Deception has an important role in cold weather warfare. The deception plan is formulated at the highest practical level. False trails are made to mislead the enemy as to the size of the force, direction of movement, and scope of activity. Rules must be established, such as single file to conceal the number of troops, restricting the blazing of new trails, and the use of fires. Additional open campfires can be started in order to deceive the enemy as to the size and true location of a force. Dummy gun and vehicle positions can be constructed using logs as gun barrels. Sound and flash simulators should be used in gun positions for a more realistic effect. All deception missions must be well planned and coordinated so that they do not contradict each other, but instead build a consistent picture of what you wish the enemy to discover. The use of electronic deception, in coordination with tactical cover and deception, is essential in concealing the location of major HQ and operating elements.

CHAPTER 8
TACTICAL OPERATIONS

SECTION 1
INTRODUCTION

SCOPE

1. Operations in cold weather regions, whether in Canada or other parts of the world, will require some specific tactics and procedures. This chapter will look at the various operations the CF might undertake in cold weather conditions and how the environment will modify or impact the operation. That being said, the basis for all land operations will be B-GL-300-001/FP-001 *Land Operations*.

PARTICULAR COLD WEATHER TACTICS

2. Any enemy conducting sustained operations in cold conditions will be forced to establish cumbersome and fragile lines of communication and supply. These will be extremely vulnerable to disruption by our forces and to the degrading effects of the climate and the harsh terrain. The forces employed against this enemy must take advantage of their strengths and attack the enemy at their weakest point.

3. By capitalizing on our knowledge of cold weather conditions and our skills in fighting in this austere environment, our forces will make maximum use of the climate and the physical environment to weaken and degrade the enemy's combat power to the point where they lose the capability to resist effectively.

4. A commander must aim to:

   a. locate and define the enemy lodgement;

   b. contain the enemy and isolate them from their support and supply lines;

   c. harass them by destroying their shelter and supplies, deprive them of sleep, food, and warmth; and

   d. destroy the lodgement once the enemy has been significantly weakened.

5. If the enemy tries to avoid engagement by constantly moving, they make themselves even more vulnerable as they must either relocate their logistics base or separate from it. If they decide on the former, they expose their essential stores to air attack. If they decide on the latter, they must open up and maintain additional local lines of communication which will consume more combat power. In either case they are liable to defeat in detail as our local knowledge, shorter lines of supply and more available air resources should give us the superior intelligence, mobility and firepower.

6. There are two possible objections to the employment of this tactic. First, for morale, political and military reasons it may be undesirable to wait for the climate and harassment to reduce the enemy's capability. Second, if the adversary seizes an inhabited area, it may be unacceptable to deliberately create hardship for civilians isolated with the enemy force. Military commanders must be aware of the alternatives in either situation and be prepared to state these clearly when seeking direction. Commanders must insist on detailed direction with regard to civilian lives, property and installations. They must also balance this against the risk to their own forces.

COMPOSITION OF FORCES

7. A force committed to operations in cold conditions must be highly mobile, preferably using tracked as opposed to wheeled vehicles. In certain circumstances skis and/or snowshoes will be sufficient. It must be stressed that in this case, assuming that the users have the required degree of training and experience beforehand, skis provide vastly superior mobility over snowshoes.

8. Helicopters will be invaluable. Rapid deployment may mean that initial operations will have to be carried out on light scales, such as using mortars rather than guns. Fighter aircraft equipped with precision munitions, if properly supported with tankers, will be of enormous assistance in providing initial firepower.

9. Due to the emphasis on using the weather as a weapon to assist our operations, accurate met data is essential. Not only are current and forecasted weather conditions vital, but a sound understanding of the long-term patterns for that area is also very important for planning operations. Much of the initial weather data will be provided by Environment Canada, as well as large-scale weather predictions over the entire AOR. However, for local conditions, which can change very quickly, a met det must be included with any deployed force.

LOCATION AND ENGAGEMENT

10. Initial reconnaissance, probably by satellite, will locate the enemy force and activity. Air reconnaissance, possibly backed up by long-range ground-patrol operations, will confirm the location(s), strength and, where possible, the intentions of the enemy. While Canadian ground forces are deploying to the area, the enemy will be engaged by fighter/attack aircraft. Different operations will have different priorities, but targets will be given a priority. One priority list might be as follows:

a. heating, electric, and water supplies;

b. HQs and communications centres;

c. supply routes and lines of communication;

d. dumps of food, fuel and ammunition;

e. vehicle/aircraft parks and maintenance facilities;

f. accommodation facilities; and

g. front-line positions.

11. In addition to actual attacks with weapons, aircraft can make overflights, drop flares or munitions, etc in order to confuse and mislead the enemy, force them to show defensive positions, increase their “alert time,” reduce sleep, destroy night vision, etc.

CONTAINMENT

12. Assuming that any airstrip in the immediate vicinity of the incursion will be held in strength, friendly forces may have to seize a separate airhead as close to the enemy as possible but out of range of effective fire. The force must deploy from the airhead to the objective area as rapidly as possible and establish a cordon around the lodgement. Depending on the force available and the size of the area captured by the enemy, the cordon may be a loose one relying on patrols and OPs, or it might be a tight perimeter completely sealing off the enemy force.

HARASSMENT

13. Once the cordon is in place, an extensive program of patrolling and probing will start to further define the enemy strength, locations and intentions. This will be the first stage of land harassing tactics, and it will be supplemented by harassing fire from indirect fire weapons and aircraft. Harassing tactics should be increased during periods of bad weather and low visibility in order to cause maximum discomfort to the enemy. Our forces should attempt to operate upwind of the enemy in order to maximize their exposure to wind chill. While these tactics will expose our forces to the elements, effective cold weather training and equipment, combined with high morale due to offensive action, will reduce the effect the environment has on our forces.

14. Harassment can be increased by using vehicles to circle or approach the enemy positions. Cold, clear air or wind will carry noise surprising distances and create apprehension among the enemy. Continuous movement, backtracking, and stopping and starting the engines will make it difficult to pinpoint vehicle positions. Overflights with fast air can further confuse the enemy as to the true situation. Other noise-producing devices including PSYOPS loudspeakers can be used to create confusion and uncertainty. Friendly EW assets should be used at the same time to reduce the enemy’s communication capabilities and prevent the passage of information.

15. Every attempt must be made to have patrols and raiding parties infiltrate the enemy positions to create fear and uncertainty and to inflict damage. Maximum efforts must be made to render shelters uninhabitable. Sources (and supplies) of power and heat should be destroyed, as should water and food supplies. Communication means such as land lines, bridges, vehicles and comms equipment should be destroyed.

16. An enemy unit that moves out of its lodgement in force should not be engaged head-on. Harassing tactics should be employed, characterized by hit-and-run attacks to the flanks and rear. Airstrikes, demolitions and attacks in depth at the enemy base should all be employed. If possible, columns should be stopped, then split into small segments, then destroyed segment by segment.

17. Enemy patrols must be located and cut off from returning to their base. Ambushes must be laid to destroy any relief forces sent out to assist the patrols. Enemy OPs should be isolated and overrun and then occupied to prevent the enemy from re-establishing the OP. Any enemy withdrawal must be followed up on, thus gradually reducing the size of the perimeter. Adverse weather may lead the enemy to abandon some locations, and these positions must be seized before they can be reoccupied in better weather. If they cannot be permanently seized, any built-up shelters must be destroyed.

18. Sustained and aggressive harassment will quickly wear down the enemy to the point where they can be overrun with minimum losses to the attacking force. When these tactics have been used in conjunction with poor weather against an isolated enemy, there may be no need for a deliberate confrontation. Regardless, if a deliberate attack is necessary, a successful harassment phase will have significantly degraded the enemy’s ability to resist.

RESUPPLY

19. To maintain pressure on the enemy it is imperative that our logistics burden be kept to a minimum. Maximum use of air resupply, including parachuting stores, is desirable. Temporary airstrips on lakes and eskers can be used by the smaller fixed-wing aircraft, but static airfields will have to be protected at a significant cost in fighting power.

ROTATION OF TROOPS AND EQUIPMENT

20. A sustained operation in cold conditions will take its toll on friendly forces as well, especially if a cordon has to be maintained for a long time. The high level of activity and long hours without rest in the harsh climate dictate a maximum of three to four days in the line before efficiency begins to drop off sharply. Commanders must pay close attention to this and be prepared to relieve forces in place, including maintenance of standing and mobile patrols. Staggered rotations, thorough briefings and continuity at the command level will allow for a smooth handover.

SECTION 2
STABILITY OPERATIONS

GENERAL

1. Stability operations are defined as “Tactical operations conducted by military forces in conjunction with other agencies to maintain, restore and establish a climate of order within which responsible government can function effectively and progress can be achieved.” In Canada, communities in the Far North are quite small in population; the larger ones have only a few thousand residents. However, there are European communities in the Arctic with populations of several hundred thousand (see Figures 8-2-1 and 8-2-2). Stability operations are part of any campaign, along with offensive, defensive and enabling tactical operations. Given the nature of many deployments to cold weather regions—not to manoeuvre forces but to support other agencies, train local forces or simply secure the population or provide humanitarian response—it is likely that the balance of tactical activities will be stability operations, see B-GL-300-001/FP-001 *Land Operations*. The CF must be prepared to conduct some or all of these operations in extreme cold conditions. Stability operations in conditions of extreme cold can occur anywhere those conditions exist, but in the Canadian North, stability operations that the CF would be expected to contribute to include the following:

a. conducting presence patrols and other activities to exercise sovereignty and reinforce national security and circumpolar cooperation;

b. disaster response and humanitarian operations;

c. assisting or contributing to Major Air Incident Disaster (MAJAID) response;

d. strengthening governance, partnerships and institutions, including infrastructure;

e. protecting the environment;

f. security and control;

g. assistance to other agencies, including NGOs, public volunteer organizations (PVO), and commercial organizations; and

h. by conducting military operations in the Far North, and by relying on existing infrastructure and people for support, helping to establish strong foundations for economic development.

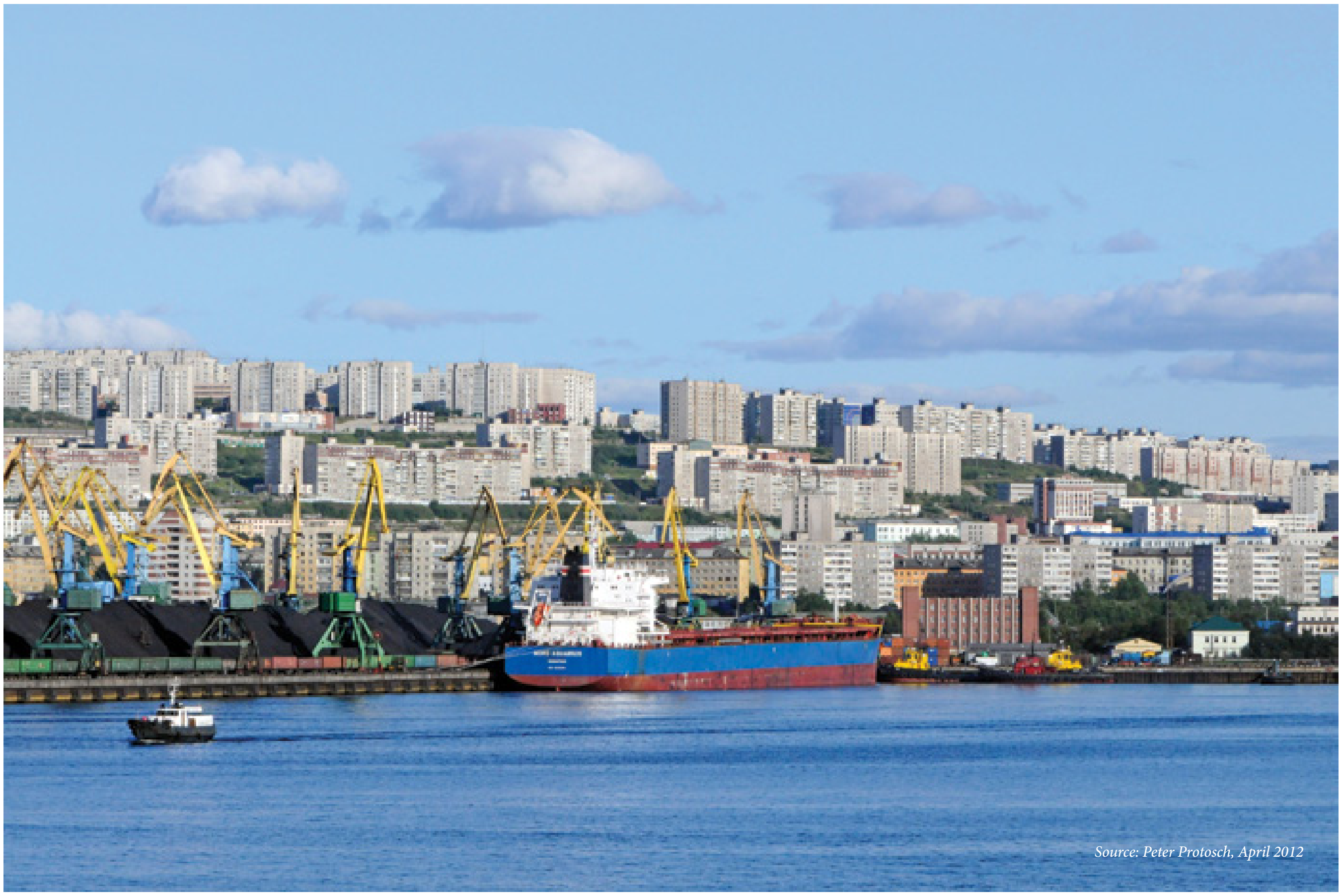
Source: Peter Protosch, April 2012

Figure 8-2-1: Murmansk, Russia, 2012

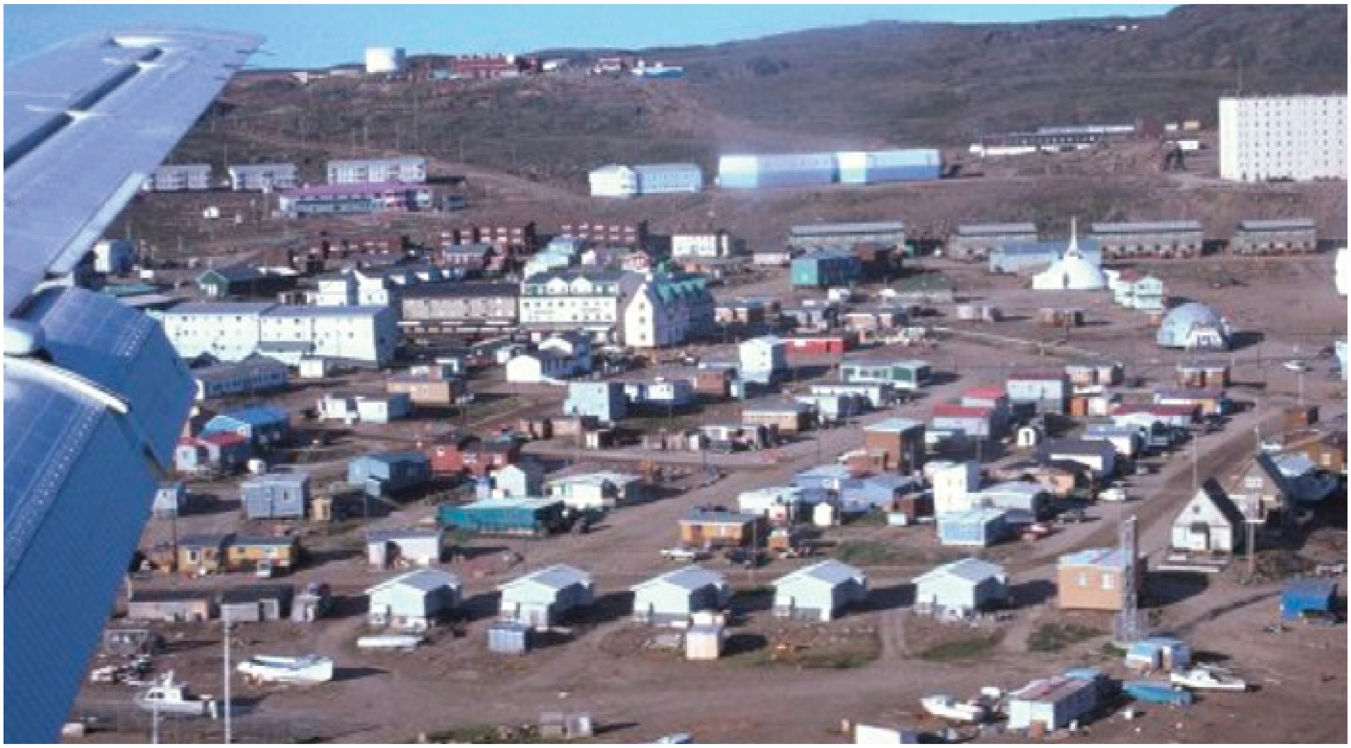

Figure 8-2-2: Iqaluit, Nunavut, 2010

SUPPORT TO GOVERNANCE

2. A critical tenet of stability operations is that they aim to meet the immediate needs of local populations. Those needs include essential services, humanitarian aid and support to local responsible government. Given the remoteness of most communities located in cold weather areas, even in parts of Europe and Asia, stability operations could also include logistical support and support to schools. Stability operations will almost always include aid and support to the various government and non-government organizations (NGO). Without conducting stability operations it is very difficult if not impossible to gain the trust and support of local populations, and without this trust and at least tacit support it is very difficult to successfully conduct operations of any sort.

SECTION 3
OFFENSIVE OPERATIONS

GENERAL

1. Offensive operations are directed towards the destruction of the enemy forces. Ideally, the objective in cold weather operations is not to pit soldier against soldier, but rather to destroy the enemy force with fire or with the elements. Actions should be sudden, violent and decisive. Well-organized logistical support will be vital. Both sides will strive to retain freedom of manoeuvre. Due to the vast distances and large operational areas, the flanks and rear areas will normally be lightly defended. They present excellent targets for envelopment or turning movements.

2. Both sides will be heavily dependent on their lines of communications, and thus must disperse protective elements to ensure that they are not severed, even temporarily. Small, well-led forces can wreak havoc by attacking these lines, as the severe winter weather will hasten a force's destruction when its supply lines are cut. Commanders must ensure that their own lines of communication are secure and look for opportunities to disrupt those of the enemy. During summer, objectives should be selected where the lines of communications cross a river or pass between two existing natural barriers.

3. Bad weather conditions increase the opportunities for surprise attacks, which can exploit falling snow, blizzards, fogs, low cloud cover and natural light illumination. Imaginative use of what appear to be weather obstacles may turn them into major advantages. However, conducting offensive operations in severe weather may restrict the use of air support and increase reconnaissance and control problems.

PLANNING CONSIDERATIONS

4. Commanders must inform their staff officers as early as possible of all aspects concerning their concepts for offensive operations so that an operation order can be formulated as far in advance as possible. This applies particularly to the logistics and administrative staff, whose arrangements for logistical support will be extremely vital in cold weather operations and will likely require additional time to arrange.

5. Reconnaissance is initiated early over a wide area in order to determine enemy locations, routes, terrain restrictions and accurate weather. However, it must also be recognized that a significant increase in reconnaissance efforts may also tip off the enemy that something is being planned. The use of space-based reconnaissance assets should be considered, if they are available.

6. Depending on the time of year and the general conditions, there is usually opportunity for manoeuvre. Main attacks should be directed against the flank or rear areas while supporting attacks are directed against the enemy front to hold them in place. An additional force may be employed to bypass the enemy position and cut routes of supply, reinforcement or withdrawal. The most mobile troops for the conditions are used to rupture the enemy lines of communication.

7. The assault should be conducted at night or during periods of low visibility. Surprise is an important factor, and the opportunities for achieving it are numerous. It may be quite feasible to deliver the assault without preparatory fire, but fire support must be available.

8. The communication plan is prepared in detail and must provide measures for overcoming the difficulties particular to cold weather operations and the harsh environment. At times, distances between two attacking forces may be so great that messages must be relayed. Radio rebroadcast (RRB) stations may have to be provided, and aircraft may act as relay stations. Satellite communications may also have to be used.

9. When attacking, units may have large gaps between them, and their flanks are vulnerable. Flank protection requirements increase. However, security requirements in the offence are not significantly different from those required in more temperate zones. Low troop density throughout the battle area, flexibility in route selection, and appropriate use of security and recce elements reduce the chances of encountering the enemy without warning.

THE DELIBERATE ATTACK

10. When reconnaissance is completed, the other preliminary measures are taken for the attack. This may have to include the opening of additional trails/roads to the assembly areas. If the distance is not too great, these trails should not be opened until the day the attacking force starts to move, as they are almost impossible to hide and will probably tip off the enemy. Line communications, when used, are laid while the trails are being broken. If possible, movement to assembly areas should be carried out during periods of darkness or low visibility. Guides may be required. Boundaries must use easily recognized terrain features, of which there may be few. It is possible that in barren, flat terrain, a GPS or astral compass bearing may be required to indicate the direction of attack.

11. The attack may be conducted by infantry on foot, skis or snowshoes, or transported by personnel carriers or helicopters. When the attack is conducted on skis or snowshoes, the attack formation should allow the use of trails broken by the lead elements of the attacking force. Every effort must be made to get as close as possible to the enemy before delivering the assault. When possible, snowshoe attacks should be conducted down slope with the wind at the attacker’s back. Troops do not halt to fire until reaching the assault position, or until enemy fire becomes effective. Assault lines should generally be closer to the enemy in winter than in summer, especially if the assault is to be made through snow. Fire support during the assault must be carefully planned, both for type and for duration. Lifting of supporting fire must occur as late as possible to give as short a time as possible for movement without the fire support. The decision as to whether the assault is to be conducted on skis, on snowshoes or on foot must be made by the commander, based on existing or predicted conditions. If skis or snowshoes are removed during the attack, they must be brought forward during reorganization.

REORGANIZATION

12. After seizing an objective, immediate attention must be paid to consolidation. The assaulting troops will likely be fatigued and overheated from the exertion of the attack. Provision must be made to prevent them from becoming cold casualties. Tent group equipment should be moved forward immediately.

13. During the reorganization, special efforts must be made to bring close support weapons forward using sleds, toboggans or vehicles if necessary. Routes must be prepared as far forward as necessary to allow this. Consideration should be given to using helicopters to move support weapons and their ammunition forward.

EXPLOITATION AND PURSUIT

14. The exploiting force must be aided by cross-country vehicles and aircraft. Airborne or airmobile troops are positioned near defiles to block the retreat of the enemy. During summer, waterways may be used by the pursuing force as a means to bring up resources, as well as a means to move patrols and raiding parties behind enemy positions to destroy bridges and cut roads.

SECTION 4
DEFENSIVE OPERATIONS

GENERAL

1. Defensive operations occur in cold weather ops for the same reasons they do in temperate conditions. In cold weather operations it may also become necessary to assume a defensive posture for short periods during break-up or freeze-up seasons, snowstorms, or periods of extremely low temperatures, when movement is virtually impossible. The defence may also be adapted to encourage the enemy to attack under conditions of our choosing, such as into long narrow passes, into deep snow, or across obstacles where movement is difficult.

2. A defence line should be based on a series of strong points covering roads, communication centres, airfields and other infrastructure. As much as possible, strong points must be sited to provide supporting fire. Gaps will be covered by patrols, including aircraft and UAVs. Use can also be made of unmanned sensors as long as they are backed up by manned systems or patrols periodically. Strong mobile reserves will be necessary so that the enemy cannot attack each strong point in isolation, destroying them one by one. Likely approaches to the strong points must be blocked and covered by fire.

3. Every well-frozen river or lake must be covered by patrols, and the larger or more important ones by fire. They can be turned into obstacles with mines and barricades, either improvised or proper. Ice blocks cut from the water can be frozen to the surface as well. Artillery and explosives can also be used to break up the ice.

4. Every sub-unit or installation must maintain all-round defence and security at all times, even during movement. This is particularly true of the vital airfields, DZs and LZs.

PLANNING CONSIDERATIONS

5. Defensive operations are difficult in extreme cold, but an enemy force conducting offensive operations will be even more exposed to the elements.

6. Special attention must be paid to maintaining battle readiness in cold weather conditions. While resting in positions, troops must be ready for immediate action. Firing positions and obstacles must be kept clear of snow. Sentries must be rotated and inspected constantly. If the defence is to be of a long duration, tents should be replaced by protected, heated shelters, preferably on the position itself.

7. An enemy offensive will probably begin with extensive reconnaissance and probing in depth to locate and define our strong points, any gaps in our defensive layout, and the location of obstacles and to disrupt our supply lines. Second, attempts will be made to isolate and destroy strong points. This will be preceded or accompanied by deep penetration elements attempting to cut and block routes, destroy headquarters and gun areas, and harass and disrupt the deployment of reserves. The battle will likely consist of a series of seemingly unrelated actions fought over a relatively wide area. The aim of the attacker will be to destroy the integrity of the defence by isolating strong points, and then to destroy the reserves sent in relief. Once that is accomplished, the strong points themselves will be attacked.

CONDUCT OF THE DEFENCE

8. The aim of the defender must be to maintain the integrity of the defence, remembering that the attacker must expend more energy on survival than does the sheltered defender. The longer the defence holds, the stronger its position will become. Integrity can be maintained by doing the following:

a. ensuring strong points are strong enough to defeat the initial attack and do not become isolated;

b. ensuring that all positions are sited for all-round defence, as well as to provide support for the positions on either flank;

c. not committing reserves until the enemy has partially exhausted themselves and ensuring that, when reserves are committed, they are sufficiently strong, with mobility at least equivalent to that of the enemy; and

d. always acting offensively to disrupt enemy supply lines, harass their headquarters and interrupt attacks before they can be mounted.

9. Counter-attacks should be of short duration and executed to hit the flanks and rear of the enemy once they have exhausted themselves and conditions have started to take their toll.

10. Due to the vulnerability of a force occupying tents or shelters, a company group is the smallest element that can make itself secure, carry out its duties and give its members sufficient rest. Strong points should therefore be organized using the company as the base. In general, company frontages will be narrow, possibly only 100 metres to 200 metres. Companies deployed in a strong point must have mutually supporting positions, preferably with other company strong points, and have all-round defence. Positions should be covered by observation points and obstacles, including anti-tank mines if there is a mounted threat. All strong points must have sufficient supplies of all types to be able to continue fighting even when isolated by bad weather or enemy action.

11. Defensive positions sited in deep snow will suffer fewer effects from enemy fire. Thick forest, fallen timber, cliffs and other natural hindrances to movement can collect snow and create obstacles to the attacker. However, heavy snowfall may also cover obstacles such as wire, ditches or anti-tank mines to such an extent that they cease to be obstacles at all. Strong points should be located on high ground, particularly during winter, as the enemy must then attack uphill in the snow.

LOCATION OF RESERVES

12. A high proportion of the force must be held in reserve during winter operations. This reserve must have the maximum cross-country mobility provided by helicopters, personnel carriers and oversnow vehicles. Reserves must be held centrally where they can react quickly to any part of the defended area. They should be held in covered and concealed positions. While in waiting, the maintenance and security of the routes forward (including snow clearance) and the reserve itself must be considered.

SECTION 5
DELAY OPERATIONS

GENERAL

1. Although current threat assessments for the defence of northern Canada do not foresee an extensive conventional threat or the need for extensive delay operations, the Canadian Forces may become engaged in other northern or cold weather operations. Furthermore, in the Canadian North, there may well be a need for small-scale delaying actions within a local plan, so the principles must be well understood.

PLANNING CONSIDERATIONS

2. The long hours of darkness in winter will provide cover for withdrawal or for delaying actions, but in summer such operations will have to take place in daylight. Maximum use should be made of fog, blowing snow and sleet storms to cover these operations. Timings should be more flexible in order to take advantage of periods of low visibility, and report lines should be close together.

3. The enemy's capacity for oversnow movement and its aggressiveness will be the primary considerations in our choice of routes, delaying positions, and allocation of troops to security tasks. The shortage of routes and the problems in keeping them open in winter can be partially overcome by having the infantry move cross-country initially and then, when possible, withdraw by air. The infantry moving cross-country will also provide a degree of security for the elements moving on roads and trails.

4. Trails should be broken rearward from positions before the withdrawal begins. Obstacles should be ready to be emplaced as the rearguard withdraws. Any possible shelter that the enemy could use should be destroyed. If the security of the forthcoming withdrawal does not allow this to occur prior to the withdrawal, then steps should be taken to destroy the shelters using delayed demolitions, artillery fire or aircraft.

5. In winter, the long hours of darkness, the deep snow and the terrain should all assist in successfully breaking contact. It is principally during actual withdrawal that the enemy, using its cross-country capability and air power, may seriously interfere with the withdrawing troops. This is particularly true of elements that are road-bound. Security and air defence must be planned for. Engineer resources must be positioned to deal with sudden snowfalls resulting in route blockage and to maintain routes in general.

SECTION 6
ENABLING OPERATIONS

GENERAL

1. Enabling operations link other operations and support the transition between different types of tactical activities. See B-GL-300-001/FP-001 *Land Operations* for details on the conduct of these operations in general.

RECONNAISSANCE

2. Reconnaissance is vital in cold weather operations. The nature of the terrain and climate, the large distances, the typically dispersed operations and the extreme difficulties of maintaining logistical support all mean that plans and initiated operations are very difficult to change at the last moment. Plans based on inadequate or poorly organized reconnaissance cannot be stopped and turned into something else quickly. Thorough and consistent reconnaissance must be planned for well in advance, but care must be taken not to wear out specialist recce assets by overtasking. In the Canadian Arctic, include the observations of the local people, particularly of the Canadian Ranger patrols, in the recce plan. Make use of long-range strategic assets such as satellites and LRP aircraft. Consult B-GL-394-002/FP-001 *Ground Manoeuvre Reconnaissance* for details on unit and formation recce techniques. Obviously, the weather and light conditions will play a large role in how recce is conducted.

ADVANCE TO CONTACT

3. The advance to contact seeks to gain or re-establish contact with an adversary under the most favourable conditions. In most of the cold weather regions around the globe, the absence of transportation infrastructure will play a major role. Speed is vital, and very careful planning of routes is necessary for rapid movement. Significant engineer assets will be required well forward to develop and improve routes. Other major considerations are moving forward and setting up of fire support elements and logistical support. Long-range artillery, rocket systems, CAS and attack helicopters can be used to provide fire over long distances. Close attention must be paid to the order of march, as it will be difficult to shuffle assets quickly along crowded and narrow routes, where bypass options will be limited. Medium helicopters, if available, can be used to bring guns or other assets forward when necessary.

4. Active reconnaissance will be necessary to continue to plan routes, to reduce time taken to switch routes and to reduce the chance of any major surprise. Flank guards and a vanguard force must be deployed to provide security and advance warning for the main body. Care must be taken to ensure that flank guards can keep up to the main movement, so special care must be taken to plan and improve the routes for the flank guards, or to provide them with the necessary mobility. The use of aviation assets should be considered, but given that there will seldom be enough helicopters to do everything, their use will have to be carefully planned for and prioritized. Airborne or airmobile forces can be deployed ahead of the covering force to seize bridges or defiles, but their logistics requirements will have to be taken into account, particularly if the link-up is delayed by weather or enemy action.

MEETING ENGAGEMENT

5. The meeting engagement is a combat action that may occur when opposing forces seek to fulfill their mission by offensive action. It will often occur during an advance to contact, and a hasty attack may be initiated immediately upon contact with the opposing force. As with any other operation in extreme cold conditions, it is difficult to rapidly carry out any unplanned manoeuvre. Possible routes are unknown and undeveloped. Deep snow may prevent vehicles, particularly wheeled vehicles from leaving prepared routes. It will be difficult to switch up the order of march along snow-bound routes, and careful thought must go into planning the initial order of march. Constant meticulous recce will reduce the chances of surprise and will help with rapid route planning. Anticipation and flexibility will be called for. The planning factors for a meeting engagement will be the same as for the advance to contact, since in most cases the meeting engagement will occur from the advance to contact. In a meeting engagement, success will likely go to the force that is the best organized and can react to events the fastest. This is particularly true in cold, snowy conditions with limited and usually undeveloped alternate routes.

LINK-UP

6. A link-up is conducted to join two friendly forces in territory that is controlled by an adversary. During much of the time when there is consistent cold weather, there are conditions of low light and poor visibility. As a result, great effort must be made to prevent fratricide. Close attention to SOPs and navigation will help. As always, recce assets can play a big part in aiding navigation and providing security during movement. Due to the potential use of airborne and airmobile forces in all cold weather operations, link-up procedures should be well practised and well understood when conducting cold weather operations.

WITHDRAWAL

7. A withdrawal occurs when a force disengages from an adversary force in accordance with the will of its commander. For withdrawals during cold weather operations, all factors that affect withdrawals in temperate conditions are valid. Planners should take advantage of periods of poor visibility. However, the difficulties in movement and the lack of developed ground movement routes may make the actual movement difficult. Thinning out will be physically difficult. It may not be possible to remove shelters, and some may have to be abandoned. If possible, they should be destroyed to prevent the enemy from using them. It may be possible to set up improvised shelters from local resources to allow tentage and pre-fabricated buildings to be removed. Strict traffic control will be vital, as routes will be few. Additional routes can be prepared before the withdrawal commences, but they should either be opened and maintained well prior to the withdrawal or immediately before, as the routes will be virtually impossible to hide.

8. If the withdrawal is identified and planned far enough ahead of time, stores may be consumed and drawn down in place rather than having a large stock in place that is difficult to remove and must be destroyed. At the same time, ample ammunition stocks must be available. Air support and long-range precision fire can be used to provide fire support. The covering force may require more mobility assets, including engineers, to help them break away cleanly.

RELIEF

9. A relief occurs when one force takes over combat activities from another. As in all cold weather operations, special attention may have to be given to establishing and maintaining the routes used by the relieving and relieved forces. Since relief operations would be carried out on a reasonably regular basis, the maintenance of the routes will not tip off an enemy that a significant activity is about to take place.

SECTION 7
WATER CROSSING AND RIVERINE OPERATIONS

GENERAL

1. Due to the nature of the terrain in most of the major cold weather regions of the world, there are usually significant waterways, including large swampy areas, lakes, rivers, river deltas and ocean shorelines and tidal areas. Given the lack of more formal transportation infrastructure, these waterways may be the best and most extensive transportation system available, both as waterways in summer and as "ice routes" once the water has frozen in the late fall to early winter period. In the summer, it may be possible to navigate along the waterways for significant distances, particularly if short portages are used to link different bodies of water. The extensive water bodies may also constitute a series of significant obstacles to offensive operations. Therefore the capability to both use the waterways for transport and cross them may be extremely useful in cold weather operations. In this manual, the term "riverine" refers to on-waterway operations that are designed to control the waterway. It does not include things like water crossings that are designed to cross an obstacle, or supply convoys that are logistics operations using water routes. For example, raids by watercraft intended to disrupt enemy supply operations along the waterways are defined as riverine operations. All personnel who consistently operate on waterways in extreme cold conditions should be equipped with survival/ immersion suits. This includes helicopter crews that ferry troops ashore or across water obstacles.

CHARACTERISTICS OF NORTHERN INLAND WATERWAYS

2. Northern waterways have the following characteristics:

   a. There are many channels, particularly when near the ocean (called "braided channels"). Typically, the channels (including the major ones) shift significantly from year to year.

   b. Watercourses may unpredictably be filled with silt, sand and other debris.

   c. Currents in major waterways are relatively swift (15–19 kph), except in the lakes, and very close to the sea.

   d. Rivers and streams have many sandbars, which often shift position.

   e. Rivers and streams are typically shallow (60–300 cm). In glacial streams the flow and depth of very cold water may double between early morning and noon as the sun heats the glacier and increases the melt.

   f. In flat coastal terrain, tides can significantly change the water depth, and salt water can sometimes penetrate significant distances upstream.

WATER CROSSINGS

3. Conducting a water crossing in the Far North is similar to conducting one anywhere else. It is covered in B-GL-300-001/FP-001 *Land Operations.* Special considerations for northern water crossings include the following:

a. The water is usually extremely cold, even at the end of the summer, and hypothermia is a very real risk if soldiers fall in or otherwise get very wet for any length of time (possibly minutes).

b. There are seldom (if ever) roads leading up to the crossing point or away from the bridgehead.

c. Given the open nature of the terrain, it is very difficult to hide the build-up of troops and equipment necessary for a successful crossing, and it will be very difficult to conceal intentions. On the other hand, this makes it fairly easy to use deception, by appearing to be crossing at other points.

RIVERINE OPERATIONS

4. Riverine operations are conducted to dominate a water system and deny the enemy its use. Riverine craft can be either purpose-built or improvised from local sources. Weapons such as the AGL, HMG and GPMG are effective in this role. Although easy to move and operate, readily available Zodiac-type inflatable craft are not ideal riverine platforms as they are very vulnerable to enemy fire. Communications, speed, endurance and firepower are important factors for riverine platforms. A high standard of watermanship is critical, as the climatic and water conditions will take a heavy toll on inadequately trained and inexperienced crews. Where possible, local residents may be able to provide guides and possibly scouts. A well-organized surveillance plan will be required to counter enemy riverine operations.

LIMITATIONS

5. Water crossings, waterborne logistics convoys and riverine operations in cold regions may be influenced by the following factors:

a. The long hours of daylight during the summer months in northern areas allow operations to be easily conducted 24 hours a day. This, of course, also means that these operations can be easily detected by unsophisticated surveillance techniques.

b. Greater use of individual motors and boats may significantly increase maintenance needs while reducing the time available to conduct the maintenance.

c. Weather is unpredictable and can change rapidly. Extreme weather in conditions of extreme cold will put soldiers at significant risk.

d. During certain times of the year flooding may submerge or destroy navigation aids or landing sites. Currents may also increase, and sandbars may shift positions, making the waterway essentially unnavigable.

e. At other times of the year low water can reduce channel depth below minimum requirements and reduce or completely eliminate that waterway’s usefulness for transportation.

f. Navigation may be difficult, particularly during times of poor visibility and will likely rely on GPS because of:

   (1) lack of detail on maps;

   (2) lack of identifiable landmarks; and

   (3) the declination and fluctuation of the magnetic field.

g. There are very few population centres along the navigable rivers in northern cold regions that can provide local support to water operations.

SECTION 8
AMPHIBIOUS OPERATIONS

GENERAL

1. Amphibious operations include assaults, withdrawals, raids and movements. Any of these can be opposed, lightly opposed or completely unopposed, across beaches or directly onto ports and piers. Amphibious operations can be conducted across or along any major body of water. Although distinct from a river crossing, they can be conducted on a large or small scale and can utilize national and/or coalition assets. Shipping assets can also be improvised using local ships and small craft. Given the lack of ground transportation infrastructure in most regions of consistent cold weather, amphibious operations can be used across the full spectrum of operations as a viable means of movement, from major combat operations to humanitarian operations. Water movement is by its nature an efficient means of movement, particularly of bulky or heavy equipment or stores. Before an amphibious operation is conducted, special attention must be paid to ice conditions where the operation is to be conducted.

2. During movement to and across the beach (or across one of the small local piers) personnel and equipment must be protected from cold-water spray. If the available boats cannot conduct a dry landing onto the pier or across the beach, then the landing force must be equipped with immersion/survival suits just like the boat and helicopter crews. Some attention must be given to providing rescue craft in order to quickly recover troops and boat crews from sunken or wrecked small boats. Survival cannot be guaranteed for troops in very cold water for more than a few hours, even if they are wearing immersion suits.

3. Equipment such as vehicles are susceptible to heavy ice build-up from spray, and the ice can damage communications gear and coat vision ports and optical equipment. Every effort must be made to prevent this prior to landing. If possible, such equipment should be landed directly on the beach or pier and not be waded ashore.

4. Given the inherent variables in temperature, weather, sea-ice coverage and infrastructure, careful logistics planning including alternative plans must be made in order to ensure that the flow of supplies will not be broken during the operation.

LIMITATIONS

5. Amphibious operations in extreme cold conditions have the following limitations:

   a. Actual ports are extremely limited throughout the Canadian, European and Asian Arctic. Port facilities (cranes, etc) are virtually non-existent except in some Norwegian and Russian towns. Some small communities along the shoreline have small piers, but they are limited in size and number. Amphibious operations in the Far North will usually be “across the beach.”

   b. Limited (or non-existent) periods of daylight, combined with typical weather patterns in the High Arctic for much of the year, will affect visibility, and extreme cold conditions will make even the simple tasks more difficult and slow.

c. Relatively light sea ice will make the operation of small boats hazardous, even during the summer. Because this ice moves around and varies in extent and thickness from year to year, the commander of an amphibious operation must be given some latitude in determining where and when the landing will occur. Close attention must be paid to the condition and location of sea (or river) ice.

d. An amphibious force will probably have to be accompanied by ice-breakers. Planners must pay close attention to historical ice data and ice recce to ensure that ice conditions will allow sea movement when required. While historical data is available to predict ice, ice movements and thickness cannot be guaranteed and can shift suddenly.

e. Airmobile movement ashore, including resupply, may be necessary from ships due to ice conditions. This is very time-consuming and inefficient compared to landing supplies from boats and ships either over the beach or onto piers. This will affect the logistics build-up.

f. A very robust logistics plan must be in place to ensure continuity of supply regardless of ice and weather conditions.

g. Shore party operations will be adversely affected by poor visibility and the cold and wet, and steps must be taken to relieve personnel regularly.

h. Once ashore, the disembarked force will be affected by the weather and operating conditions ashore. If possible, shelters should be set up to allow personnel ashore to change out of wet clothing.

6. Air support for amphibious operations in the cold weather areas will be hampered by the weather, periods of darkness and poor visibility. The potentially long transit times to the operational location may reduce air support, but modern precision-guided munitions and aiming devices should not be significantly affected. Once the aircraft are actually on station, air support should be effective. Air support coordination will be very important.

7. If called for, naval gunfire support should be available throughout the landing. The heated weapon systems on the ships should function without difficulty. Modern naval fire-control systems should provide accurate fire until the force’s integral indirect and direct-fire assets are in place. It must be borne in mind that current warships have limited weapons suitable for shore bombardment.

SECTION 9
AIRMOBILE OPERATIONS

GENERAL

1. Airmobile forces can overfly obstacles, swiftly cover medium distances, and arrive on or very near the objective ready to fight. Reinforcements can be delivered rapidly and effectively under all but the worst weather conditions. Because of the speed and the independence from ground transport, it is quite possible to achieve surprise by using airmobile operations.

2. The relative short range and low speed of most helicopters precludes airmobile operations from being conducted over great distances. The helicopters themselves may have to be flown into the AO on fixed-wing transports, to an air landing facility relatively near to the objective. The same transports likely will have to fly in bulk fuel, maintenance facilities (shelters, etc), spares and C2 elements.

LIMITATIONS

3. Temperate region airmobile doctrine is applicable to cold weather operations with some limitations. These limitations include the following:

a. It is important that units have trained for and conducted airmobile practice in cold conditions and have developed and/or practiced cold weather SOPs.

b. Loading plans must be modified. Although helicopters actually function better and have more power in cold weather, the much bulkier loads required for cold weather ops will take up space within the helicopter. These loads include the requirement for rucksacks, Arctic toboggans, extra food and fuel and other related items. Helicopters will often “bulk out” before they reach their weight limits.

c. Limited visibility operations. The tactical situation may dictate the conduct of airmobile operations during periods of darkness or limited visibility. Night vision devices will be extremely useful for night-time operations, but flares and helicopter-mounted searchlights may also be useful to illuminate AOs. Operations conducted in snowy areas during full-moon conditions may require little or no artificial light or night vision goggles (NVGs). Some care must be taken when using multiple helicopters in conditions of deep snow, as the rotor wash may create whiteout conditions. Helicopters may have to be spaced out 100 m or more, or at least land and take off 30 seconds apart, to reduce the effect of blowing snow.

d. Weather minimums must be established early in the planning to determine the least acceptable weather in which the commander will permit the operations to be mounted. Weather factors which must be considered in planning and conducting cold weather airmobile operations include temperature, density altitude, wind speed and direction, icing, visibility, turbulence, and snow and ice conditions. Current aviation weather forecasts are essential. It is also important to have access to any flight reports of pilots actually operating in the proposed area. Weather reconnaissance flights should be made on a regular basis. One of the enduring characteristics of cold weather regions is the speed at which weather can change.

e. Plans must be made for aeromedical evacuation of airmobile force casualties. This is a problem of immediate urgency during periods of sub-zero temperatures, including battle and "cold" casualties. Dedicated aircraft should be considered and be made available throughout the operation.

f. Due to the large size of a typical LZ, establishing and maintaining the security force will be an issue. Airmobile operations also require significant personnel to off-load and distribute supplies and stores, as it is unlikely that significant mechanical transport will be immediately available. Furthermore, the threat of a high-mobility enemy reaction force means that it is essential to maintain an all-round defence of the LZ. Sufficient forces must be identified, transported and maintained for these jobs throughout the operation.

g. In much of the Far North in Canada, Europe and Asia, the extremely limited land transportation system means that special attention must be taken to ensure the link-up with the airmobile force, with the risk of isolation and destruction if this cannot be achieved quickly. If a link-up cannot be made quickly, a significant proportion of the available helicopters and air transports may be taken up re-supplying the isolated force.

h. Depending on the operation and the threat, attention may have to be paid to conducting suppression of enemy air defences (SEAD) along the flight routes chosen. With the risk posed by heavy machine guns (HMGs) and man-portable air defence systems (MANPADSs) to helicopters, careful planning of both in and out routes is vital. Medium-range air defence (AD) systems can also pose a risk to even low-flying helicopters over long distances in the Far North. Attack helicopters (AH) and light observation helicopters (LOH) may have to be used as escorts. Utility helicopters (UH) and cargo helicopters (CH) can provide some cover using door guns with the gunners equipped with NVG systems. However, the extreme cold conditions due to wind chill will affect the gunner's ability to function if aircraft doors remain open. This extreme cold may also affect the troops that are to be landed.

i. There will seldom be sufficient helicopters to conduct all aviation tasks that are needed, and commanders will have to prioritize their needs. Helicopters are maintenance-intensive, and heated shelters must be available to ensure that maintenance will take a minimum of time regardless of the outside temperatures. Intensive aviation activities will also consume large amounts of fuel, and logistics planners will have to ensure that it is available.

j. Once an airmobile force has been landed, until ground forces have linked up with it, it will be totally dependent on aircraft for resupply. That will reduce the number of helicopters available for other aviation tasks. Depending on the situation, that may also include escort helicopters. Depending on the risk assessment, dropping large amounts of supplies by transport aircraft using precision air-drop systems can be considered.

CONDUCT OF AIRMOBILE OPERATIONS

4. Due to the whiteout and wind chill caused by the rotor wash, troops should not be on the LZ when the helicopters touch down to pick them up. Trails must be broken from the troop positions to the individual pickup points. Given that weather conditions can change rapidly and result in delays due to conditions being below weather minimums, troop shelters should be set up at the troop positions to provide shelter. When deplaning, troops should move immediately off the LZ with all their equipment to reduce the risk of frostbite from the rotor downwash.

5. During winter periods, lakes can be used as LZs, once ice thickness has been checked. Thickness can be checked by pathfinders. Lakes provide LZs with unobstructed approaches, the depth of snow will likely be less, and the trees, other vegetation and snowdrifts along the shore will provide some concealment for troops and equipment. Beaches and other level areas will provide stability for LZs during other seasons. Particularly in winter, LZs should be as close as possible to the objective in order to reduce the time and effort needed for approach marches. If enough fire support is available, thought should be given to actually assaulting right onto the objective. That fire support could be provided by AH, close air support (CAS) and long-range precision fire.

6. When unloading in the landing area, troops will frequently be completely disoriented. A crew member in each aircraft must tell the ground commander which way is north. Remember that if the AO is in the Far North, standard magnetic compasses will probably not work. Commanders must orient themselves as thoroughly as possible prior to touchdown so that assembly can be accomplished with the least possible delay.

SECTION 10
AIRBORNE OPERATIONS

GENERAL

1. Given the lack of ground transportation infrastructure, it may be that the only way to insert a force into the necessary AO is by parachute. Although airborne operations have great initial strategic mobility, once the troops have landed they will be almost entirely reliant on aircraft for resupply, and the number of vehicles that can be provided will probably be small. This means that once on the ground, the mobility of airborne forces will be very limited. Airborne operations, by definition, encompass both airborne assault and air-landed operations. Airborne assault means a landing with opposition expected, whereas an air-landed operation would not expect fighting on arrival. Airborne assault may be a parachute assault or an air assault landing. Unopposed air-landed operations are not considered special operations.

LIMITATIONS

2. In addition to the limitations of airborne ops outlined in B-GL-300-001/FP-001 *Land Operations,* B-GL-324-004/FP-001 *Airborne Operations – Parachute* and B-GL-324-002/FP-001 *Airborne Operations – Airmobile*, there are a number of additional limitations due to the effects of extreme cold:

a. the increased effect of weather and its unpredictability (blizzards, fog, whiteout);

b. navigational difficulties caused by inadequate charts and maps, and lack of natural landmarks and human-made structures. These difficulties are greatly mitigated by the modern navigational aids carried by the aircraft, and by extensive use of GPS;

c. heavy or deep snowdrifts on airfields and LZs which can cause problems with snow removal or equipment recovery;

d. the potential lack of landing strips and the difficulty of constructing one, particularly in the summer; and

e. difficulties with communications.

SELECTION OF DROP ZONES AND LANDING ZONES

3. The following factors must be considered:

a. the requirement for visual or photographic coverage;

b. the preferred use, whenever possible, of frozen inland water surfaces of sufficient strength;

c. areas of muskeg that look excellent on photographic or map inspection but that may prove to be covered with frozen hummocks of vegetation up to one metre in height;

d. the depth and type of snow and configuration of drift; and

e. summer swamp and muskeg conditions that can restrict the use of many otherwise desirable zones.

FORMS OF ASSAULT

4. When considering the form of assault (parachute or air assault landing), the following should be borne in mind:

   a. the area of the lodgement in relation to the distance from the nearest landing facility;

   b. the strength of the force that can be concentrated in the assault area in one lift at any one time;

   c. the time gap between the initial insertion and any follow-up insertions;

   d. the strength, position and armament of the enemy; and

   e. the availability of supporting fire of all types.

5. A parachute assault will normally be launched when the enemy either occupies or is situated so as to deny the use of airfields or LZs, or when no airfields or LZs exist. Once a landing area has been secured, engineers may be landed to build an austere airstrip to enable follow-on forces and logistics supplies to be flown directly into the landing area.

6. There may be situations where troops can be air assault landed sufficiently close to the lodgement that movement to it by foot or vehicle may be possible. This can occur if the adversary has failed to capture an airstrip adjacent to the lodgement. In the long run, possession of an adequate airstrip, either previously existing or purpose-constructed, is an enormous asset.

SPECIAL CONSIDERATIONS FOR PARACHUTE ASSAULT

7. The following factors must be considered when planning an parachute operation under conditions of extreme cold:

   a. Special attention must be paid to resupply of the parachute force. Unexpected bad weather can keep resupply aircraft grounded for days or even weeks at a time. Due to ground movement conditions, ground link-up can be seriously delayed. Therefore, any parachute operations should be self-sustaining for at least seven days.

   b. To avoid overheating personnel, aircraft troop compartments should not be warmer than -4 degrees Celsius.

   c. Rapid DZ assembly procedures and the use of assembly aids are especially critical in cold weather operations where considerable difficulties may be encountered in forming up in tree-covered areas, in deep snow or during extended periods of darkness or poor visibility. Search parties must rapidly locate missing personnel who may have been injured.

   d. During the snowy season, toboggans with tent group equipment must accompany units on the initial drop, and all parachutists should drop with snowshoes and/or skis.

   e. Special effort must be made to quickly recover equipment that is delivered by parachute.

CONDUCT OF THE ASSAULT

8. The difficulties of navigation, short winter days, the chances of sudden bad weather and the difficulty of really knowing the quality/suitability of the DZ make the use of pathfinders highly desirable if they will not prejudice the subsequent operation. If a parachute drop is to be made close to the enemy lodgement, the pathfinders can be inserted using high-altitude low-opening techniques, by dropping them just before the main drop, or by dropping them some distance away from the DZ and having them infiltrate onto it by land. Pathfinders can be deployed from helicopters or fixed-wing aircraft, by boat or by any other technique available. Every effort must be made to achieve surprise.

9. Assembly after landing in periods of poor visibility on featureless terrain will be difficult. Special markings for assembly areas and troops and equipment should be considered. For periods of very low visibility, highly visible beacons may have to be used, with obvious implications for security.

10. Once inserted, troops may have to move during periods of darkness or poor visibility to avoid enemy fire. Large amounts of fire support may be unavailable or available only intermittently to cover movement or suppress fire.

11. While dropping paratroopers, aircraft—whether fixed-wing or helicopters—are extremely vulnerable to ground fire, and even more so to dedicated air defence weapons. SEAD must be considered along planned routes and on the DZ itself. Suppressive fire can be provided by any combination of tactical air, AHs, or long-range ground-based systems.

12. Once the landing commences, assembly and reorganization of the ground force must be conducted immediately. Additionally, heated shelters must be set up for casualties and PWs, and possibly for the assaulting force depending on the ground plan. Casualties and PWs must be evacuated as soon as possible.

SUMMER CONSIDERATIONS

13. The conditions for summer operations are similar in most respects to operations in temperate zones, but there are some significant differences, including the following:

a. Hours of darkness will be extremely limited, and in some cases non-existent, and that must be taken into account for planning.

b. Despite the relative warmth and bright sunshine, bodies of water will remain very cold. Parachutists who land in water will become cold casualties within minutes unless dressed in immersion suits. Once in the water, unprotected individuals will become incapacitated and helpless within minutes and will quickly die. Unless they have landed in very shallow water near the shore, they may not be able to rescue themselves.

c. Much of the Arctic in Canada, Alaska, and Europe is quite mountainous and may require mountain equipment, techniques and experience. Depending on the altitude, winter equipment may be necessary at the height of summer.

d. Much of the lowlands will be covered in muskeg. Foot and vehicle movement is difficult or even impossible in the soft, swampy ground conditions.

SECTION 11
DEEP OPERATIONS

GENERAL

1. Deep operations are those operations conducted at long range and over a protracted time scale against adversary forces or resources not currently engaged in close operations. Given the long, tenuous lines of communications in the North, the difficulty in providing supplies, and the cost and time of moving these supplies, deep operations against resources can be one of the most effective techniques used against an adversary. An unsupplied force in cold weather conditions will very rapidly lose the ability to conduct operations and will have to withdraw or surrender. In addition to raids by ground forces, deep operations can consist of air interdiction, long-range precision indirect fire from rocket and artillery systems, and AHs that penetrate the forward edge of the battle area (FEBA) to operate deep into the enemy's rear. Deep operations can also take the form of attacks on air installations, air and naval interdiction against supply ships, or mining operations against enemy ports.

RAIDS AND OPERATIONS IN THE ENEMY'S REAR AREAS BY GROUND FORCES

2. In modern cold weather operations there are usually no continuous fronts. Units may operate independently many miles apart. Installations are isolated, and communication lines, where they exist, are long and vulnerable to attack. This makes it relatively easy to insert raiding parties throughout the AO and then extract them. Surprise is always a possibility, and security can only be guaranteed by accurate knowledge of enemy organization, disposition, movement capabilities, and constant vigilance, including use of patrols and sensors, both manned and unmanned. Conditions, both operational and environmental, facilitate raids on communication centres, headquarters and installations of all types. Patrols and stay-behind forces are well suited to these operations. Severe weather conditions enhance the effect of such operations.

3. The primary task of long-range patrols will be for reconnaissance and raids on isolated positions and enemy rear areas. These patrols may form part of the overall harassment campaign or be used

a. as diversions for an attack elsewhere;

b. to prevent or cause the movement of enemy reserves;

c. to force further dispersion of enemy forces;

d. to give a presence in a disputed territory; and

e. as part of stay-behind forces in the event of a withdrawal.

4. The insertion, supply and extraction of patrols, casualties, prisoners, documents or equipment will often be carried out by air. Ship or submarine insertions, resupply and extractions are also possible. Patrols can also be inserted through gaps between enemy units using LOSVs and other ground techniques. Patrols must be capable of rapid movement and must be able to operate for long periods between resupply.

5. The effectiveness of long-range patrols fundamentally depends on their ability to live under rigorous conditions and the speed with which they can move across country. All ranks must have a high degree of endurance and expertise in travel, whether by snowshoes, skis or vehicle. If possible, they should have some capability to survive on and live off the land.

SECTION 12
OPERATIONS ON PERMANENT ICE- AND SNOW-COVERED AREAS

GENERAL

1. Operations on permanent ice- and snow-covered areas may be required for the establishment of support facilities and the protection of specialized activities such as weather stations, or to carry out attacks on adversary installations. In such instances operations will normally involve small elements, seldom larger than sub-unit and usually much smaller. Despite the small size of the elements committed, due to the distances involved and the difficulties inherent in operating in such an area, the total effort required will be significant.

2. Operations on an ice cap are so different from other cold weather operations that different techniques are required. Troops require specialized training for operations in this region of high winds, ice ridges and crevasses. The complete absence of useable resources (except ice and snow) means that every last item must be transported to the operating area, and all garbage (including sewage) must be transported out. Storage and maintenance shelters can be constructed from snow and ice to provide shelter from the wind. Snow and ice conditions must be closely monitored to ensure safety, as conditions can change rapidly.

EQUIPMENT

3. Specialized equipment (and training) for negotiating the area is required. This will include oversnow vehicles, tractors, trail marking equipment, navigational aids for aircraft and vehicles, portable shelters, crevasse detectors, crampons, ice axes, ropes, folding ladders (for crossing crevasses) and other related equipment.

SECTION 13
CBRN OPERATIONS IN COLD WEATHER

GENERAL

1. Although it is difficult to conduct chemical, biological, radiological and nuclear (CBRN) operations in conditions of extreme cold, it can be done. The cold affects both offensive and defensive techniques and procedures, and it is important to understand those effects. The low troop and civilian population densities typical in cold weather areas will make CBRN operations less likely to be conducted, and it will be even more difficult than usual to conduct really successful attacks. At the same time, given the typically low civilian populations, an enemy will have fewer political constraints placed on them concerning the use of offensive CBRN weapons. Forces must be vigilant for evidence that CBRN agents have been used. Formations and units must rely on expert advice when conducting CBRN operations in extreme cold conditions. The small populations in most cold areas mean that there is limited industrial plant and seldom much risk from toxic industrial materials (TIM), as they are simply not present in significant quantities. Just as in temperate AOs, if a CBRN threat is identified, a CBRN Coordination Centre must be set up and staffed in order to provide warning and reporting to the deployed units, and specialist CBRN assets will be assigned as necessary.

CHEMICAL

2. Chemical agents, either toxic industrial chemicals (TICs) or war-fighting agents, will be significantly affected by the cold. Extreme cold will tend to freeze chemical agents solid and either prevent them from off-gassing completely or reduce the off-gassing significantly. Different agents freeze at different temperatures. This means that cold chemical agents may be difficult or impossible to detect with available detectors. They may also be covered by fresh snowfalls, which will seal in the agent and prevent it from dispersing at all. Areas that are contaminated with chemical agents may not show contamination until temperatures warm up in the spring, melting the snow and exposing the agent. If soldiers (or civilians) get frozen chemical agents on their clothes and equipment, then enter heated shelters, the agents will warm up and off-gas. In small shelters, a lethal build-up of agent can occur very quickly. See Figure 8-13-1 for a list of common chemical agent freezing points.

SERIAL	AGENT	TYPE	FREEZING POINT IN °C
1.	Phosgene (CG)	Choking	-118
2.	Chloropicrin (PS)	Incapacitating	-69
3.	Hydrogen cyanide (AC)	Blood	-15
4.	Mustard (HD)	Blister	-14
5.	Mustard Lewisite (HL)	Blister	-26
6.	Tabun (GA)	Nerve	-50
7.	Sarin (GB)	Nerve	-56
8.	Soman (GD)	Nerve	-42
9.	Chlorine	Choking	-100
10.	Ammonia	Choking, blister	-78

Figure 8-13-1: Freezing Points of Some Chemical Agents and TICs

BIOLOGICAL

3. Extreme cold does not kill biological agents. Both viruses and bacteria are routinely frozen in labs to preserve them. UV light from sunlight rapidly destroys most biological agents (except for spores, which will have to be destroyed with special decontaminants such as chlorine solutions), but the periods of reduced or non-existent sunlight during late fall, winter and early spring will protect bio agents. The opposite occurs during the periods of almost constant sunlight during the summer months, when the many hours of sunlight will destroy most biological agents fairly quickly. Biological agents can also be contained in snow and released when the snow melts in the spring and early summer. Frozen biological agents can also be brought into heated shelters on clothing and thawed out. Given the usually cramped conditions in Arctic shelters, once individuals are infected, retransmission occurs very quickly. Timely detection of biological agents is difficult even under normal conditions, and in extreme cold the difficulty is greatly increased. Very close attention must be paid to signs of unexplained illness. Most biological agents, if detected and identified in time, are relatively easy to defeat with antibiotics and anti-viral treatments.

RADIOLOGICAL

4. Dirty bombs typically use conventional explosive to distribute radioactive particles that are alpha or beta emitters. Unless inhaled or ingested, these particles are not particularly dangerous, and the thick environmental clothing will stop them from penetrating the body, but they are difficult and time-consuming to clean up. Given probable low troop densities and small civilian population centres, it is unlikely that a dirty bomb would or even could be used effectively in the Far North. However, one might be used in extreme cold conditions farther south where population densities are higher.

5. Radiation itself is not affected by extreme cold, but its effects may be modified by conditions. Radioactive particles may be masked by heavy snow, but they may also be blown around by heavy winds that spread radioactive particles farther than normal. In winter conditions, radiation particles can be removed by scraping up and moving the top layers of snow. Heavy, dense snow that falls after an attack can mask radiation particles and make them difficult to detect with standard detection equipment. However, the cold itself does not affect radiation detection, and if the detector batteries are kept warm radiation detectors will function well in extreme cold conditions.

NUCLEAR

6. Although it is unlikely nuclear weapons will be used in any northern region, as more and more nations acquire either nuclear weapons or the capacity to make them, the possibility cannot be entirely discounted. Nuclear blasts will create alpha, beta, gamma and neutron radiation. Field fortifications and armoured vehicles will protect from alpha and beta radiation and offer some protection against gamma and neutron radiation, but the latter two forms of radiation are both far more damaging to humans than alpha or beta radiation. The effects of nuclear weapons can be significantly affected by snow and extreme cold. Deep layers of snow and ice will absorb some of the shock wave and can significantly reduce it. However, frozen ground without snow cover will increase the shock wave. Clear, dry air will also increase the light and heat radiation from a nuclear blast, particularly at night, but falling and drifting snow or heavy fog will reduce this effect, as will the heavy clothing and sunglasses worn by soldiers to protect them from the environment. Extreme cold conditions will not affect electromagnetic pulse.

7. The cold, dense air will significantly reduce the distance initial radiation will travel, by as much as 25 per cent. However, fallout patterns may be extended significantly, both by the high winds that are so common in cold conditions and, in the winter months, by the movement of contaminated snow. Radioactive particles will get caught up in snow and will then be blown across the countryside by the typically high winds. This should result in lower dose rates (due to dispersion), but over a larger area. As with all CBRN agents, fallout particles can be carried into shelters on clothing. If fallout is suspected, clothing and equipment should be brushed off before being taken into shelters or trenches.

PROTECTIVE MEASURES

8. As in all operations, a proper risk assessment must be carried out prior to the deployment. CBRN protective garments retain their protective levels in extreme cold conditions, but they will make it difficult to adjust layers of clothing to conditions. Although the standard detectors do actually work well in cold conditions, the cold and snow may mask agents, making it difficult to detect them. Battery use always presents difficulties in conditions of extreme cold. Temperature change can have a very significant effect on the ability of agents to off-gas, and temperature must be watched closely once a CBRN attack is suspected or confirmed. A well-drilled warning and reporting system must be in place and practiced. Respirators and protective clothing must be available to the dispersed elements of the force. Detectors must be available in large numbers when troops are dispersed, along with a supply of spare batteries. As always, a high level of training in individual protective drills is vital in a suspected CBRN environment.

CBRN RECONNAISSANCE AND SURVEY

9. Cold temperatures will present problems for CBRN recce and survey. Vapour pressures of chemical agents may be low or almost nonexistent, and agents may be encapsulated by snow. Given the smaller amounts of chemical agent present, very basic detectors such as 3-way paper may react very slowly if at all. It may be necessary to heat samples of snow thought to be contaminated in order to ensure that vapour can be detected. Shelters must be checked with detectors regularly and, if possible, aired out regularly. In extreme cold conditions, CBRN recce and survey will take an even longer time to conduct than in temperate conditions. Contaminated areas must be well marked with tall signs to ensure that snow does not cover them. Detectors must be used very close to the surface to detect low vapour concentrations. Contamination will typically last much longer, as the agent will off-gas and disperse much more slowly. Once snow cover melts in the spring, areas must be surveyed again to detect agents that were covered by fresh snowfalls during winter.

CBRN SURVEILLANCE AND MONITORING

10. Surveillance and monitoring will be affected in much the same way as reconnaissance. Detectors must be set up close to the surface and should not be allowed to become buried in snow. They will have to be remounted after each fresh snowfall. Samples may have to be taken and heated at regular intervals in order to detect whether chemical vapours are present.

DECONTAMINATION

11. Chemical decontamination is difficult in extreme cold conditions. Water-based decontaminants can freeze, particularly if sprayed on cold vehicles, where ice build-up can affect hatches and vision ports. Ice build-up on vehicles can actually keep the agent contained and prevent natural weathering. Contaminated and wet or frozen clothing is difficult for an already overstretched log system to launder or replace. Reactive Skin Decontaminant Lotion (RSDL) will freeze solid in low temperatures and should therefore be carried in pockets inside the outer garments. Tests have been carried out on RSDL, and it can be frozen and thawed several times and still retain its decontamination properties, although it cannot actually be used when frozen. If there is a high risk of contamination, replacement stocks of environmental clothing will be necessary.

12. It is very difficult to decontaminate biological agents, but two methods that can be used are exposure to sunlight or exposure to strong sodium hypochlorite (chlorine) solutions for 15 minutes (note that chlorine will kill spores, but sunlight will not). In far northern areas, except for the short summer, there may not be enough sunlight (UV rays) to quickly destroy other biological agents, and they can persist for long periods. In extreme cold, biological agents may be frozen and have no effect until thawing eventually occurs and they are exposed to greater amounts of sunlight.

13. Nuclear decontamination consists of brushing off or removing clothing, footwear and equipment (including vehicles and aircraft) and physically removing the top layers of snow or earth containing the radioactive particles.

CHAPTER 9
SUSTAINMENT

SECTION 1
INTRODUCTION

GENERAL

1. The principles of land force sustainment do not change in cold weather operations. However, techniques employed must be adapted to the environment. Flexibility in planning and full use of resources will be the key to success. Each operation will be unique, and the sustainment system must be able to adapt. Sustainment failures will have a more disastrous effect on operational plans in cold weather ops than in temperate zones because there will be few options to compensate for deficiencies.

2. Cold weather operations may have to be mounted on short notice, therefore administrative planning must be continuously updated and anticipation must be constant. Stocks must be readily available for deployment on little notice, and all equipment must be maintained at a high standard. Combat Service Support (CSS) personnel must be as trained and experienced in cold weather operations as possible.

SECTION 2
THE LOGISTICS CONCEPT

MOUNTING

1. The outline plan for mounting cold weather operations is discussed in Chapter 1. The system of mounting, supporting, and forward bases used to deploy a force will also be the technique used for follow-up logistical support. All logistics requirements will be funnelled through the supporting base to the forward base and/or to the airhead (when one is required). Expeditionary ops to northern or cold regions will use the same concepts but will utilize airports of disembarkation (APOD) and seaports of disembarkation (SPOD) to stage into the supporting base as opposed to infrastructure in southern Canada for domestic ops. See Figure 9-2-1 for a diagram of the forward basing concept.

FORWARD BASING

2. Ideally, the forward base will be superimposed on an existing CF or Coalition installation. In the absence of a CF or Coalition facility, it may be a civilian complex. In the worst case, the facility may have to be built up from nothing if no facilities exist. The key requirements are heated shelter and storage plus a runway capable of accepting at least medium transport aircraft (CC130 or equivalent) and preferably strategic transport aircraft (CC17 or equivalent). If necessary, prefabricated shelters may have to be moved in and assembled.

3. A task force of brigade size would normally have the following located in the forward base:

   a. the headquarters (HQ) of the support unit, usually the Service Battalion (Svc Bn);

   b. second-line functions of the Svc Bn, such as transport, supply and maintenance;

   c. a Role 2 medical facility, including a medical holding facility;

   d. helicopter and fixed-wing aircraft maintenance elements;

   e. reserve stocks of supplies and equipment; and

   f. reinforcement holding unit.

AIRHEADS

4. When the distance from the forward base to the enemy renders effective administrative and logistical support impossible, an airhead will be established. As the combat elements deploy from the airhead, their echelons will build up within the airhead. For protracted operations, these unit echelons will be centralized under the higher HQ control. Some elements or functions of the forward base may move into the airhead, but strict control must be exercised so that the administrative facility does not become a burden on the fighting units. In order to further reduce supply issues, commanders should consider air drops or helicopter resupply operations when formulating resupply plans.

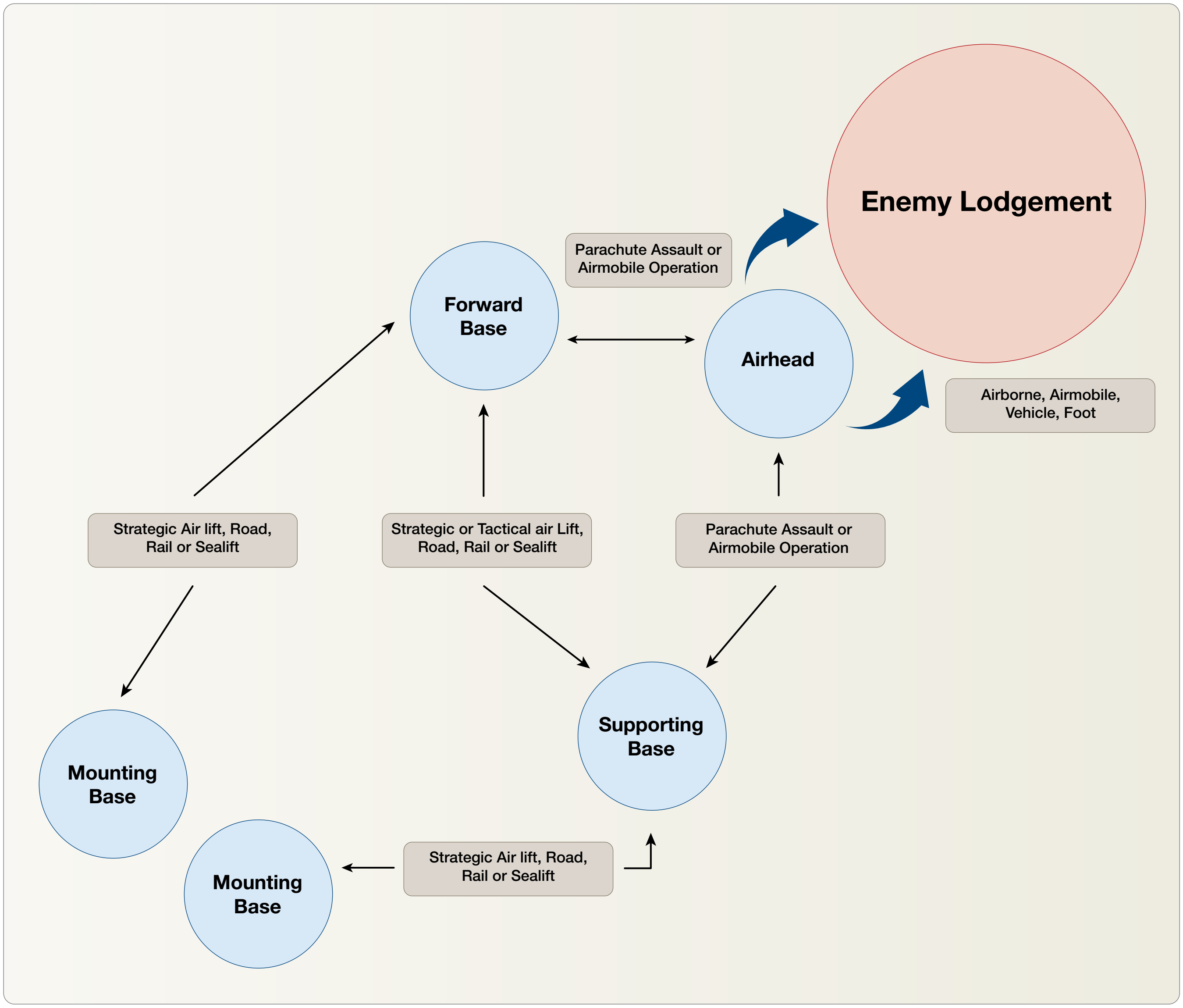
Enemy Lodgement
Parachute Assault or Airmobile Operation
Forward Base
Airhead
Airborne, Airmobile, Vehicle, Foot
Strategic Air lift, Road, Rail or Sealift
Strategic or Tactical air Lift, Road, Rail or Sealift
Parachute Assault or Airmobile Operation
Supporting Base
Mounting Base
Mounting Base
Strategic Air lift, Road, Rail or Sealift

Figure 9-2-1: Base System for Mounting Operations in the Canadian North

HOLDINGS

5. Holdings at all levels must be constantly monitored to ensure sufficient stocks, while at the same time ensuring that forward elements are not overburdened. Supplies will be palletized as far forward as unit echelons, using the PLS system or standard civilian-pattern wooden pallets. Unit loads of all commodities will be prepared at the forward base when possible, in order to limit handling in the airhead.

DISTRIBUTION

6. Limited carrying capacity, high fuel requirements, difficult terrain, and a limited infrastructure do not lend themselves to the standard distribution system (ie, the use of delivery points). The logistics plan must allow for the forward delivery of all items.

7. The following distribution systems, all of which lend themselves to use of air (primarily helicopters) must be considered. If the plan includes operating transport helicopters close to enemy-held locations, enemy air defence systems must also be taken into account:

a. direct delivery where supplies are delivered direct in unit or sub-unit echelons;

b. delivery points where supplies are delivered to echelon areas, where they are cross-loaded to unit vehicles for forward movement; and

c. air “milk run” where logistics aircraft (including helicopters) loaded with common requirements fly a circuit delivering requirements directly to sub-units. In this case special care must be taken to avoid enemy air defence assets.

8. By virtue of the many uncontrollable factors affecting the use of air (weather, maintenance, etc), if possible (availability of roads, etc) ground transport should always be available as a backup, and possibly to move the heavier and more bulky items (ie, artillery ammunition) that a lack of helicopters might make difficult to move quickly in the amount required.

MAINTENANCE

9. In cold and extreme cold conditions, unit vehicle technicians must be formed into teams, and a team should accompany each convoy of vehicles to perform first-line repairs on the spot. The forward repair group sited in the forward base will perform recovery tasks and second-line repairs. Due to the harsh conditions, maintenance requirements will be significantly higher, and increased stocks of parts will be necessary. There will be a requirement for additional technicians and additional recovery assets.

10. The forward base will often be the farthest forward area where second-line repairs can be made on an efficient, ongoing basis. Some covered and heated maintenance facilities will be absolutely mandatory in cold weather operations. If possible, covered and heated facilities should be set up at unit locations in order to support maintenance efforts forward and reduce the need to recover all vehicles back to the forward base.

SECTION 3
LOGISTICS PLANNING

GENERAL

1. The following factors will affect logistics planning:

   a. Long distances, harsh terrain and severe weather will have a pronounced impact on the performance of personnel and machines.

   b. There is an absence, especially in more remote regions, of good ground communications.

   c. Problems of camouflage and concealment in open areas lead to problems of concentration vs dispersion.

PREPARATION PRIOR TO DEPLOYMENT

2. All available data on the AO must be studied for logistical implications. Government and military data banks, as well as those of any other organizations operating in the area, must be consulted, and lists must be prepared of those items that will be required but are not normally part of the military supply system. Equipment scales must be tailored to need, and all equipment and stores must be checked for serviceability and completeness. This is particularly important with respect to spare parts.

3. Movement staff tables are to be reviewed and adjusted as necessary.

4. Depending on the time of year, winterization procedures may have to be carried out on equipment.

LOCAL RESOURCES

5. In temperate zones, operational considerations will outweigh many civil factors. However, in more remote regions, this may not be acceptable or even possible due to problems inherent with moving refugees out or supplies in. Remote towns are typically small with limited shelter. The same issues affecting military supply apply to towns and civilian transport. In lightly populated areas, few towns will have sufficient stocks of any commodity to provide significant resources to a force of any size. Significant interdepartmental discussions will be necessary in order to determine government priorities. These decisions will not be made by the military.

6. The following are some aspects of this problem:

   a. During large-scale, protracted operations, it may be easier to evacuate all or some of the local civilians for the duration of the operation. If this is done, special efforts will be required of the government to care for the displaced individuals.

   b. The general impact of large-scale military operations, especially the large numbers of young, fit soldiers on small communities with limited resources and population, must be considered.

   c. If they are not evacuated, there may well be numbers of unemployed local civilians available for hire for general labour.

d. The impact of local purchases and the hiring of local labour must be considered in light of its effect on the local economy.

e. Planners must understand that given the difficulty and cost of resupply, there will probably be very few local stores available for purchases.

7. In spite of the limitations listed above, particularly on small-scale operations, there may well be considerable expertise, specialized facilities and equipment available in many remote communities. The early establishment of liaison with local government and civilian agencies will determine what assistance can be given to the military and what assistance the military may have to give to the local community in a crisis. If at all possible, it is important that this be planned for and negotiated before the operation begins.

SITING OF ADMINISTRATIVE AREAS

8. Since the supporting and forward bases will almost always be based on existing facilities, planners will not have much flexibility in their general layout. In most cases the fixed facilities will be limited. The points discussed are more pertinent to an airhead, but may be considered when comparing two potential locations or when additional facilities must be added to an existing plant. Maximum use must be made of local facilities in order to reduce preparation time and to limit the tonnage which has to be moved into the area, but it must also be understood that existing facilities may be extremely limited or otherwise simply unavailable.

9. The following factors should be considered:

a. proximity to any road or trail network that exists, however limited. It must be recognized that in some cold weather areas, there simply is no road or trail network;

b. suitability for transport aircraft, especially medium and heavy transport aircraft;

c. availability of hard standing (for aircraft, vehicles and stocks). Good soil conditions (rock, sand, and gravel) are necessary to minimize the unfavourable effects of permafrost;

d. suitability for concealment is important. It will probably be impossible to completely conceal the site, but the detailed layout must be disguised if possible. Timbered or built-up areas will assist this;

e. proximity to local resources (such as fuel and heated shelter), including natural resources such as forests;

f. communications systems such as long-range radio or telecommunications systems belonging to other government departments. In this case, normal tactical siting of radios will still apply;

g. the size of the available area may be vital. Dispersion may be very important in the face of a significant enemy air threat. If there is no air threat, a much tighter deployment will ensure efficiencies; and

h. protection from high winds, which may be provided by locating on the downwind side of hills. Remember that cold air flows to the bottom of valleys, so locations approximately halfway down the hill are best. Areas subject to frequent avalanches must be avoided.

SECURITY OF LINES OF COMMUNICATION AND CRITICAL INFRASTRUCTURE

10. Specific provision must be made for local defence of each logistics complex, including vehicle convoys, airfields and LZs, echelon areas, and static stocks. All personnel must be integrated into local defence plans. Defence plans, where possible, should include provision for blocking air strips and other cleared areas against helicopter and airborne landings. There will be increased demands on logistics personnel, so the use of manoeuvre elements from the forward units may be necessary to assist in local protection. Local civilians must be on the lookout for unusual people and activities, and the means of passing this information on to our forces must be well known.

SECTION 4
TRANSPORTATION

GENERAL

1. If any one factor outweighs all others in mounting cold weather operations, particularly in remote areas with limited infrastructure, it must be transportation. A good transportation system will provide the lift where and when required and always have alternative means and plans for when the original plan breaks down. Limited resources mean maximum use must be made of whatever is available. The same systems are used in regions with modern infrastructure, but due to the lack of ground transport infrastructure in remote regions, including the Arctic and Subarctic, the emphasis changes from land to air movement. This is particularly true in cold conditions, where ground communications deteriorate even more. Air transport is least susceptible to climate and terrain, but is also by far the most expensive. The correct balance of all available means must be the aim of all transport planning. It must be noted that in many parts of the Canadian, European and Asian Arctic, and even the Subarctic, roads simply do not exist or are very limited in extent. Simply put, it will not always be possible to use ground transport for resupply without first building a significant road network. This is particularly true during the fall and spring, when the ground will not be hard or dry enough to support significant ground transport.

2. Conventional second-line transportation may have to be re-equipped with appropriate vehicles. The transport unit might be located in the forward base or at the airhead if the operation is sufficiently forward of the airhead. The tactical air maintenance section (TAMS) teams will be the most heavily committed single element in the transport unit. Surface transportation may be an alternative, but it will be primarily employed as local transport at the airfields.

3. Throughout this manual, reference is made to high- and medium-mobility carriers with heavy, medium and light capacity. This classification, along with some examples by type, is shown in Figure 9-4-1.

MOBILITY	CAPACITY			REMARKS
	Heavy	Medium	Light	
High		M113A3/TLAV LAV III MOSV	LOSV (winter) Dogsled (winter) ATV (summer)	Primarily off road vehicles, multi-wheeled or tracked
Medium	HLVW AHSVS	MSVS	G Wagon or civilian-pattern light truck	4–6-wheel drive
Low	Commercial pattern vehicles			2-wheel drive

Figure 9-4-1: Mobility Classification of Vehicles. Vehicle types are examples and the list is not exhaustive

AIR

4. The characteristics of aircraft types, their classifications and the limitations placed on their operation in the Arctic, and in cold weather operations in general, are discussed in some detail in Chapter 6, *Air Operations in Cold Weather*. Despite the limitations, the advantages gained by carefully planned air movement of personnel and equipment so surpass those of other movement methods that, where possible, air movement will probably be the primary technique employed. However, even with modern aircraft equipped with modern navigation systems, there will be times when aircraft cannot fly due to conditions, or there will be insufficient aircraft available, and this must be accounted for in planning. Alternative methods of delivery and reserve stocks must be accounted for and, whenever possible, air supply must be replaced or supplemented by other means of movement.

5. The distribution methods discussed earlier all lend themselves to the use of air movement. However, lead time for planning is extended, and a flexible priority system must be established. Logistics planners must have access to information on aircraft and crew availability, load capacity, airfield locations and weather predictions to make effective use of resources.

6. The complete lack of alternative supply systems, especially in Arctic regions in winter, means that deployment and resupply may be necessary totally by air. Since the size of forces envisaged is typically not large, this should not be impossible, but the significant limitations must be borne in mind at all times.

ROAD

7. The Subarctic is dominated by forests, swamps, rivers, streams and lakes. In most of the Subarctic, very few roads or even trails exist, and often operations will be based on only one road which may not be an all-weather route and is certainly not paved for its entire distance, if at all. In winter, significant resources will be required to keep the roads open, and wheeled vehicles (particularly 2-wheel-drive vehicles) may have considerable difficulty along these routes. Any conventional wheeled vehicle will be restricted to roads and prepared routes. In spring and fall (and sometimes summer) the road beds are generally soft, and this will restrict both loads and numbers of vehicles, especially heavy vehicles. Significant effort by specialized engineer assets will be necessary to develop roads and then keep them open. During the depth of winter, ice roads on lakes and waterways may be developed, but great care must be taken not to allow significant forces to be isolated during spring break-up, before the conventional roads (if they exist) are useable.

8. In the Arctic proper, there are even fewer roads, and they are almost always immediately around communities. These roads are usually restricted to eskers and high ground. In winter, the ice on lakes and waterways (including the ocean) can sometimes be developed into high-capacity roads. Snow roads can be used by high-mobility vehicles with little preparation. However, extensive new road construction in the Arctic summer is beyond the capacity of engineer field squadrons, except around airfields and communities.

9. Second-line transport will need to be a mix of high- and medium-mobility vehicles. Medium-mobility vehicles will be restricted to roads. Low-mobility vehicles will seldom be able to traverse the poor roads, and will be essentially useless out of towns. As a result, every effort should be made to equip units committed to the Arctic and Subarctic regions with modern commercial high-mobility vehicles. Wheeled high-mobility vehicles will be the most flexible, as they will be economical on roads

and still retain a useful cross-country capability. While tracked vehicles have a far superior cross-country performance, they will rapidly destroy any roads, and this must be taken into account. In all cases, vehicle crews must be provided with snowshoes and/or skis, shelters, food and heating equipment.

OFF ROAD

10. Various types of high-mobility carriers are available for cold weather operations requiring cross-country capability. Vehicles will be oversnow or through-snow depending on the design. Combat vehicles can be employed as prime movers for sleds and trailers when the operational situation allows. Commercial-type caterpillar tractors have also been successfully employed as prime movers. The latter can move extensive tonnage over long distances through heavy snow, but they are very slow.

TRAFFIC CONTROL

11. Road networks, where they exist, are limited, and frequently only allow traffic one way at a time. Movement is normally hazardous during the winter months due to ice and snow. Visibility is often poor due to blowing or falling snow, frequent ice fog and long hours of darkness. This poor visibility in turn extends the time of operation, as vehicles will often operate under blackout conditions. Good traffic control arrangements are necessary to compensate for these conditions. Conditions are easier in the summer months, but the poor and limited roads require good traffic control in all the seasons. II (image intensification) and TI (thermal imaging) low-light systems will help maintain traffic control and increase speed of movement somewhat. Traffic control measures must be strictly enforced. MPs may be available to assist in traffic control, but all elements of the force should be prepared to participate in this vital duty.

12. Route markings are standardized by international agreements (civil and military), and are covered in B-GJ-005-404/FP-030 *Road Movement*. Local regulations must be followed by all concerned. All hazards such as curves and road junctions should be marked with delineator stakes with reflectors positioned along the outside limits of the road shoulders. Delineator stakes are also useful to indicate bridges and edges of contour-bound mountainous roads. In barren lands (lacking landmarks), the trail may have to be marked on both sides. Care must be taken to place the stakes high enough that they will not be covered by a snowfall. Once the road has been ploughed a few times, the snowbanks will clearly mark the road. The marking guides should be of different shapes and colours to clearly mark the routes up and down as well as the routes themselves. Formation SOPs should clearly outline this practice. The stakes must also be clearly visible using TI and II night-vision devices.

13. Rapid reconnaissance over routes can be conducted using either helicopters or tactical UAVs. The frequency of route reconnaissance will depend on weather conditions, density of traffic use, types of vehicles being used, and threat of enemy action along the route. Where the land routes exist, road reconnaissance should be conducted as often as possible.

14. Traffic control posts and checkpoints requiring continuous operation in winter months will necessitate the doubling of personnel. A buddy system must be established and shelters provided. Communications and reflective accoutrements must be provided for all traffic control personnel, including reflectors for TI and II devices.

15. Depending on conditions, primary land routes and regularly travelled air routes should have survival shelters located at intervals which provide emergency sources of food, heat and shelter from storms. In addition, vehicle operators and aircrew must carry extreme cold weather survival gear (including communications gear independent of vehicular systems) in their vehicles in case of mechanical breakdown. Traffic control personnel must ensure that no vehicle packet will leave the base area without this survival equipment.

RAIL

16. Railroads are virtually non-existent in the Canadian Arctic but do exist in the Arctic regions of Europe and Asia. They also exist in much of the Subarctic around the world. In terms of land transport, when available, railroads are far and away the cheapest and most efficient means of moving large amounts of freight, including heavy vehicles. When using rail facilities, tactical loading must be used to allow uninterrupted unloading in the railhead area where limited facilities and parking space are available. Particular care must be paid to the unloading of cold soaked vehicles. Train weights may also be limited due to lightweight rails and the low load capacity of bridges. Use of rail transportation in the Far North can also be hampered by poor visibility, heavy snowfall, snow slides and extreme temperature changes. That said, the capacity of even a low-grade railroad will usually far surpass what is possible by road.

WATER TRANSPORT

17. When inland waterways are used they can only form part of the total transport system. Regardless of the tonnage or distance carried by water, stores must still be distributed upon arrival. That being said, it is relatively quick, and large bulk items are easily moved on navigable rivers, lakes and oceans. The requirement for specialized handling equipment may limit water transport. Water transport is also only possible for part of the year, and close attention must be paid to freeze-up. The following military and civilian resources should be considered:

a. There are very few actual ports/docking facilities in the world’s cold weather regions, particularly in the Arctic, which means cargos are typically discharged “over the beach.”

b. Power boats with shallow draft can be employed for both troop transport and supply movement in upstream areas. They can be used to tow improvised rafts and barges.

c. Near the mouths of large rivers, ship-to-shore lighters may be used effectively to unload large ocean-going vessels. The mouths of most Arctic rivers are quite shallow, and large ships may have to anchor quite a distance off, which will increase unloading time.

d. Long-distance bulk river transport barges of conventional commercial design can be used on navigable rivers, and are likely available.

e. Use of natural waterways for logistical support may require extensive effort to dredge channels and lay out navigation aids, piers and the like. Except for rivers that routinely carry civilian traffic, none of this exists on northern Canadian, European or Asian rivers.

18. It is also possible to use a series of lakes and rivers, portaging the supplies and possibly the smaller boats over short passages of land between the water features in the traditional Canadian canoe portage technique. However, the actual portages can be time-consuming and personnel-intensive. It will seldom be possible to move very heavy and bulky items by this method.

19. During the winter, ice roads can be relatively easily prepared on rivers, on lakes, and along the seashore, but they then require significant effort to maintain in useable condition. Additional details on ice roads can be found in this manual at Chapter 5, Section 3, *Maintaining Mobility*.

20. A northern supply route by water, during ice-free periods, is less difficult and more efficient than other means of transport. Ships are self-sufficient, requiring very little refuelling or servicing at their destination. Supplies can be delivered on a large scale with minimum hazard to personnel, equipment or stores, as long as the necessary facilities exist to receive them.

21. In the ocean areas of the north, movement possibilities and timings can vary widely from year to year depending upon the severity of the preceding winter season. Most areas of the Arctic Ocean bordering on land typically have eight to ten weeks each year when ice permits the passage of ships. These periods usually occur during late July, August, September and possibly early October. Because this time period varies significantly from region to region and from year to year, up-to-date records and weather predictions must be consulted for the specific region in question. When using ocean shipping, tides will have to be taken into account for some movement, and for unloading, particularly if done "across the beach." In all cases when operating around the oceans, and in some cases for significant distances up some rivers, the tides will have to be taken into account.

22. Ocean navigation is restricted by the movement of the ice pack, which is governed by the winds, tides and currents. The prevailing shallow water and the numerous migrating sandbars further complicate the problem. Topographical data may be ancient or missing altogether. New, up-to-date data must be recorded and passed on at the conclusion of every trip.

23. Cargo discharge is hampered by the lack of sheltered harbours, shallow water, the absence of wharves and cranes, and the distance a ship may have to anchor from shore. In some cases, ships may be able to ground themselves on mud flats during low tide and are unloaded into vehicles that drive out on the mudflats. Poor visibility will restrict observation and make unloading difficult if the ship anchors well out from shore. Marker buoys may have to be placed along the entire ship-to-shore route. In good weather it is perfectly possibly to deliver supplies directly onto any beach, although this technique is cumbersome, labour-intensive, and very time-consuming.

24. Resupply of small parties (particularly clandestine parties) by diesel submarine may be possible, given enough open water for recharging batteries. Nuclear-powered submarines, although larger and noisier, are able to operate freely under the ice as long as there is open water where they want to drop off, pick up or resupply their parties.

25. Once a ship or barge is unloaded at the port area or over the beach, the supplies must be distributed to the units by air or ground transport with all their inherent limitations in the Far North, and this factor could restrict the useful supply rate of water transport.

SECTION 5
SUPPLY

GENERAL

1. Transportation difficulties in cold weather will have a significant effect on the supply function. All elements must carry sufficient stocks to carry through the periods when additional supplies cannot reach them, or cannot reach them in sufficient quantities. The second-line supply element will normally be located at the forward base, although it may have elements in the airhead. Maintenance and replacement problems mean that no substandard equipment can be tolerated when a force is operating in cold weather conditions. Units should be established with at least an additional 10 per cent pool of all spare parts, personal and group equipment. Some of this replacement equipment must be pushed down to sub-unit level, particularly during dispersed ops. The supply organizations must be able to replace damaged or destroyed equipment almost immediately, because the consequences of lacking critical equipment can be extremely serious.

STOCK LEVELS

2. Standard loads and consumption rates designed for conventional war in a temperate zone will have to be reconsidered in light of cold and extreme cold weather requirements. Each operation will be unique with respect to duration and intensity. Seasonal considerations will have a considerable effect on scaling. Changes of season must be planned for far in advance to prevent being caught out by a sudden freeze or thaw which could shut down all resupply efforts other than by helicopter. Due to the uncertainty of resupply due to weather and poor or non-existent infrastructure, holdings down to sub-unit and even sub-sub-unit level may have to be larger than what is considered normal.

3. Combat supplies consist of ammunition, petrol/oil/lubricants (POL), rations and water. Of these items, only rations and water requirements can be predicted with any certainty. POL consumption will be greater than in temperate zones due to requirements for heating shelters, greater use of fuel for vehicle movement, and the possible requirement for melting ice and snow for water. Ammunition consumption will usually be low due to the typically isolated small-scale actions, but this cannot be guaranteed. Additional considerations with respect to combat supplies are as follows:

a. **Food Holdings.** The following figures are based on rations, but also apply to POL and ammunition depending on actual consumption rate.

   (1) one day (plus emergency ration) with individual;

   (2) three days with the tent group;

   (3) two days with the subunit (A1) echelon;

   (4) five days with the unit (A2) echelon;

   (5) ten days held at the forward base.

b. **Water Holdings.** Producing water (in winter) by melting snow at the tent group level uses large amounts of fuel and is time-consuming. In addition, it causes a great deal of condensation on tentage, which means tents must be replaced much more frequently, as wet tents lose their insulating characteristics, freeze and tear. Tents with ice accumulations also take much longer to warm up once they are occupied. If possible, bulk water should be obtained from lakes or rivers and delivered to all elements of the force—a far more efficient procedure. Provision of bulk water is an engineer responsibility. It may not always be possible to provide bulk water to all front-line forces, but it is important to do so whenever possible. Bulk water distribution to rear area elements is a must. In some parts of the High Arctic it may be necessary to provide water by desalinating ocean water.

c. **POL Holdings.** The extensive use of tracked and all-wheel-drive vehicles with a high rate of fuel consumption in cold weather conditions, along with the fuel requirement for heating, must be considered when planning for POL requirements. This will produce an abnormally heavy POL requirement. Arctic-grade diesel, anti-freeze, denatured alcohol, and special oils and greases which remain fluid in extreme cold are some of the special POL requirements for cold weather operations.

4. **Spare Parts.** Due to higher equipment failure rates at low temperatures, spare parts stocks must be increased above normal levels. Since unit loads must be kept to a minimum, the bulk of these parts will be held at unit and formation. Spares must be available, but proper storage will be limited. Back loading of equipment will be more frequent, as explained in Chapter 9, *Sustainment*, Section 6, *Maintenance*. Major assemblies may be flown direct from the supporting base on demand in order to reduce holdings in the operational area.

5. **Clothing and Equipment.** Environmental clothing, especially during winter, must be immediately available to replace damaged items. Torn, damaged, wet or POL-impregnated clothing and tentage is dangerous, and replacements must be held down to subunit level. Facilities must be made available for drying tents whenever possible. Ensure that sufficient quantities of snow knives, shovels, cookers, snowshoes, skis and other cold-weather-specific equipment are available.

6. Engineer and defensive stores should not be consumed at rates significantly higher than what is normal in temperate zones, and it is relatively easy to store them.

STORAGE

7. It may not be practicable to hold stores on the vehicles due to the high vehicle usage rates. During winter months, supplies must be stored on pallets or raised platforms to prevent them from freezing to the ground. Supplies stacked in the open must be placed to keep the effects of drifting snow to a minimum. Stacks of pallets can be partially protected from freezing together by covering them with a tarpaulin and keeping ice and snow off them. In this case the commodities must be clearly signed for easy identification. Poles and flags may have to be used to mark the location of stores and to provide a guide for snowploughs and other snow-removal equipment. Poles must always have reflective tape. Waste and salvage dumps must be well marked and recorded in order to assist cleanup. All Canadian environmental laws must be followed when possible, and when this is not possible due to operational imperatives, great care must be taken to record locations where cleanup will have to be undertaken upon conclusion of operations. Special care must be taken with supply items which are subject to freezing. Batteries, fuses, medical stores and some types of rations must be kept in dry, heated storage, away from moisture.

8. Gasoline and diesel fuel may be stored in large, flexible containers at low temperatures, although the containers cannot be easily moved and are subject to damage from handling at temperatures below -34 degrees Celsius. At extremely low temperatures, flexible containers and hoses become brittle and break easily. If the container or hose breaks and spills fuel on a soldier, instant frostbite can result. Fuel containers and drums should be stored vertically, tipped at a 20-degree angle, which will allow water in the container to concentrate and freeze in the bottom corner of the drum. When fuel is being pumped from the container, it should be drawn down to the upper level of the base of the tilted container, leaving about five gallons in the barrel. This will significantly reduce the possibility of water being transferred into the vehicle fuel tank.

9. During the summer season, well-drained ground must be selected for storage sites. Care must be taken not to tear up the muskeg by moving supplies back and forth needlessly. Gravel pads, if available, may make storage easier.

10. There are storage issues for some medical supplies. Certain drugs, medicines, vaccines and equipment must be kept in a warm, dry, climate-controlled location.

DISTRIBUTION

11. Whenever possible, unit (and sometimes sub-unit) requirements will be packaged on pallets or containers and moved as far forward as possible. When roads are being used, it will be necessary to establish an RV where stores will be cross-loaded to unit high-mobility vehicles for cross-country movement. Every effort must be made to reduce the number of transfer and break of bulk points to a minimum. Depending on the threat, security may have to be provided at each stage of the supply process, as our supply lines will be a vulnerable and high-payoff target, just as the enemy's are to us.

LAUNDRY AND BATH

12. Due to the extreme importance of keeping clothing and personnel clean in cold weather conditions, mobile laundry and bath unit (MLBU) elements will deploy with any force operating in cold conditions for a sustained period without ready access to a suitable local laundry facility. Ideally, it should be located as close to the forward troops as is tactically possible. However, due to its requirement for water, large amounts of fuel for heating, its heat signature and a requirement for protection, it may be located in the airhead. At any rate, dirty clothes will rapidly lose their insulating properties, and the capability to keep environmental clothing clean is vital in a cold environment.

13. The MLBU element should be located beside a sizable stream or lake to ensure a steady water supply and to reduce the chance of the water freezing before delivery. The MLBU also will require a facility for proper disposal of the large amounts of grey water generated by the laundry. Note that, due to environmental restrictions, this grey water cannot simply be dumped on the ground.

SECTION 6
MAINTENANCE

GENERAL

1. A considerable amount of special maintenance is needed to prepare equipment before any operation in a cold environment. There are additional special procedures required during and after use. Remember that the cold environment causes abnormal wear and tear on all items of equipment. These factors combine to greatly increase maintenance requirements and problems.

2. Additional factors complicating the maintenance problem in cold conditions are the following:

   a. the requirement for heated maintenance facilities for all equipment;

   b. difficulties in back loading broken-down or damaged vehicles over rough terrain with a limited road system;

   c. problems in moving mobile repair teams (MRTs) forward to broken-down equipment; and the difficulty for the MRTs of effecting repairs on the spot;

   d. the high consumption of spare parts;

   e. the time required for equipment to warm up enough for repairs to be carried out; and

   f. the inordinate amount of time required for simple repairs.

MAINTENANCE PERSONNEL

3. Maintenance personnel will be hampered in winter by low temperatures, blowing snow and darkness and in summer by dust, abrasive sand and insects. A high standard of personnel and unit discipline is required to overcome the natural inclination to seek personal comfort. Bulky environmental clothing, particularly gloves and mittens, will increase the time required to complete even simple tasks. During periods of extreme cold, care must be taken to ensure that bare flesh does not touch cold metal.

4. Fuel coming into contact with bare skin results in supercooling due to evaporation, and can cause painful freezing within seconds. Repair time may be increased as much as fivefold when personnel are doing field maintenance in extreme cold conditions (below -40 degrees Celsius). The installation, maintenance and repair of engine pre-heaters and personnel heaters, as well as changeover to Arctic lubricants, will require many hours to complete.

PREVENTIVE MAINTENANCE

5. The satisfactory performance of any type of mechanical and electronic device is enhanced by a high standard of maintenance, therefore a good preventive maintenance and high-quality repair program is essential. A prerequisite for improving the performance of modern forces is to ensure that all systems are in good repair and that lubrication and adjustments have been made in accordance with appropriate technical manuals. This is particularly true in conditions of extreme cold.

6. Machined surfaces that produce heat will rust rapidly in cold weather because of the condensation caused by cooling, so they must be kept clean at all times. Objects that do not produce heat will have little problem with rusting if maintained at a constant temperature. Equipment that is moved into and out of heated areas will have condensation form on its surfaces and will rust rapidly if not kept clean and dry at all times. Operators must be aware of this.

WINTERIZATION/ARCTICIZATION

7. Winter operations in regions of extreme cold (consistent temperatures below -21 degrees Celsius) require that all vehicles and equipment be winterized. This must be done prior to deployment from the warmer regions of origin. Fuel tanks should be filled with Arctic-grade fuel before deployment. (Arctic-grade diesel fuels have additives to ensure that they burn properly at extremely low temperatures, and “Arctic grade” is the technical term for these cold weather fuels.) Failure to carry out these tasks will result in unacceptable performance at -40 degrees Celsius. Replacement equipment being delivered after the commencement of the operation must be carefully checked to see that winterization was carried out, preferably prior to shipping. For transportation on aircraft, vehicle fuel tanks must be filled no more than two-thirds full to prevent spillage at high altitude.

8. Winterization procedures are detailed in current equipment technical manuals, but most of the data is concerned with operating above -37 degrees Celsius. When temperatures are likely to be below this level, Arcticization must be carried out. Maintenance staffs must issue special instructions to enable this to be done.

RECOVERY

9. Recovery of damaged, broken or abandoned equipment must be accomplished as soon as possible in order to prevent them being buried in fresh snowfall or becoming inaccessible in muskeg during thaws. While vehicles will not be back loaded or destroyed in significantly higher numbers in cold weather ops, more breakdowns will likely occur, so overall numbers of available vehicles may be an issue at any given time.

MISCELLANEOUS TASKS

10. Maintenance elements will be responsible for minor modifications carried out in the forward area. The variety of terrain and climate over a long period will create a need for local modifications in order to keep equipment at top efficiency. Limited manufacture may be required, but this is unlikely to happen ahead of the forward base. The dissemination of technical information to users will be an ongoing requirement based on the conditions encountered.

SECTION 7
MEDICAL

GENERAL

1. The principles of first aid taught in general military training apply in extreme cold regions just as they do in more temperate areas. The extreme cold greatly increases the requirement for speed in evacuation and treatment. A serious casualty must receive first aid and environmental protection (possibly in a casualty bag) following injury. Due to the potential rapid loss of body heat, the possibility of shock from any injury in cold conditions is significantly greater, and signs of shock must be carefully watched for.

2. Personal hygiene is very important in cold regions. Personal bathing will be difficult, but everyone must wash regularly. Clean clothes are extremely important since dirt and dried perspiration will not only increase the chance of disease, but will also significantly reduce the insulation properties of clothing.

3. An adequate supply of good nutritious food and plenty of water is essential to health. Fresh, centrally cooked rations should be provided where possible, and they must be served hot. Hard rations must be properly cooked and fully consumed. At least 4 litres of liquid per person per day are required.

MEDICAL INSTALLATIONS

4. The increased need for rapid treatment of casualties, coupled with the difficulty of ground transportation at all seasons, means that unit aid stations (UMS) and elements of the field ambulance must be deployed well forward in the combat area. As a result, some thought must be given to security of the medical installations, including routes in and out.

5. There are few large-scale medical facilities available anywhere in the remote areas around the world where extreme cold conditions are routine, and if significant casualties are expected, then large-scale medical facilities (sized to perceived need) will have to be set up prior to the operation. There are a number of pre-fabricated systems suitable for this. Due to the large medical logistics footprint, including issues with heating and lighting, this can be a significant issue. Where they exist, local civilian medical facilities will not be staffed or equipped to deal with large-scale casualties, and the strain of attempting to handle them will overload civilian resources far beyond their capacity. Also, if the limited civilian medical facilities and equipment are used for the military, they will not be able to deal with local civilian needs. Civilian medical resources cannot be replaced without a major logistical effort and cost, and that may not even be possible, depending on the time of year.

TREATMENT

6. Casualties in extreme cold conditions will be evacuated to rear areas as soon as possible. Treatment in the forward area will normally be limited to that supportive of immediate emergency work and successful evacuation. Evacuation to rear areas will be conducted by air whenever possible. Forward holding times should be kept to a minimum, but due to the uncertain flying weather at many times of the year a holding capability must exist at all medical levels.

EVACUATION

7. The evacuation of casualties must be carefully considered. The initial process of evacuation starts where the soldier is hit or injured. Due to the scarcity of roads, this can be difficult. In periods of heavy snow, oversnow vehicles may have to be used, but at other times it may be possible to use ATVs. In periods of extreme cold temperature, enclosed vehicles will have to be used. However, it is very possible that the initial evacuation may have to be conducted by foot. For this reason, provision must be made for stretcher bearers in all units, whether they are provided for in standard establishments or not. In winter months, troops moving on foot must be followed by casualty toboggans pulled by stretcher bearers. All vehicles, including those operating on the few available roads, should be fitted for stretcher kits. This is particularly true of high-mobility vehicles, as they will often be the sole mechanized means of reaching and moving casualties. Unit medical elements must have the same degree of mobility as the force they are supporting, and their vehicles must be enclosed and heated.

8. Evacuation of walking wounded can become a problem in some cold regions where there are no prominent terrain features for personnel to follow to the UMS. Snowstorms, blowing snow, fog and cloud further hamper the movement of wounded personnel by limiting visibility to within a few feet of the individual. Routes can be signed, but this will create a potential security issue for the UMS. If wounded must “self-evacuate” by walking, as a minimum, they should be sent in pairs. In extreme conditions, improvised tent groups should be sent, including some non-wounded personnel. Although not desirable, it may be necessary for casualties to remain with their units until the weather improves and permits movement.

9. Once outside the immediate combat area, air medical evacuation will be used to move casualties to facilities in temperate areas where treatment and care are much easier. Helicopters may be necessary to move casualties to the airhead or forward base to allow air evacuation to take place.

10. Commanders at all levels must give consideration to how they will evacuate their casualties, and they must recognize that casualty evacuation is both vital for morale and incredibly intensive in terms of labour and mobile equipment. Speed is of the essence (weather permitting). Logistics aircraft may be used to carry ambulatory patients out, but dedicated medical evacuation flights may be necessary for the severely injured and during intensive operations. In some cases, private or commercial aircraft may be used, if available.

MEDICAL STANDARDS FOR DEPLOYMENT IN COLD WEATHER

11. In addition to normal prerequisites, the following conditions may limit how troops can be used under conditions of extreme cold. All field service troops liable for employment on cold weather operations should be checked for the following:

a. circulatory problems affecting body extremities;

b. skin grafts on the face;

c. inner ear problems;

d. previous history of severe cold injury; and

e. dental fitness.

12. Individuals trained for and assigned to carry out specific duties not involving frequent or prolonged exposure to the elements, or to be employed in the warm season only, are exceptions to the restrictions listed above.

COLD CASUALTIES

13. Cold casualties can often be the fault of the individual or of faulty decisions by leaders at various levels. Individuals must be responsible for their own protection up to a point, but the section, platoon and company commander must be responsible for taking the necessary action to counter the hazard of cold weather. This will include close supervision, reducing periods on guard duties, slower movement with shorter but more frequent halts, and the use of shelter. All personnel must be routinely checked to ensure that they are properly dressed for the level of activity. The task force commander is also responsible for taking action to reduce casualties to troops working outdoors in conditions of extreme cold. Troops can move and operate in most extreme cold weather conditions. However, they must be in excellent physical condition, well trained and well led.

14. Minor casualties can be expected when carrying out simple, routine duties, including cuts and bruises caused by the loss of dexterity as a result of the bulky clothing. Frost burn from touching cold metal with bare hands is a potential problem. Accidentally pouring fuel over the hands when filling stoves and lanterns is likely to result in second-degree frostbite. POL-contaminated clothing loses its insulation properties and can produce frostbite in the area of contact. Knowledge and supervision will reduce these problems to an acceptable level.

SECTION 8
PERSONNEL MATTERS

REPLACEMENTS

1. During cold weather operations, environmental conditions demand that replacements be properly equipped and receive appropriate cold weather indoctrination prior to moving to the operational area. Once trained and moved up to the forward base, replacements must be given time to acclimatize to the cold conditions before reporting to their units for duty. The minimum recommended acclimatization time is 72 hours.

MORALE AND DISCIPLINE

2. Extremes in temperature and harsh terrain, the long periods of darkness, and the isolation are factors which can have a marked effect on morale in extended cold weather operations. Strong, good leadership at all levels is essential to maintain good morale. The overall health of the soldiers and their confidence in their ability to meet the rigours of northern operations is related directly to their physical condition. The effect of good physical fitness on morale cannot be overemphasized.

3. Fit, well-disciplined troops who are properly trained can operate effectively in almost all conditions. Unceasing supervision at all levels is mandatory, particularly during periods of extreme cold. The weather and terrain encountered in extreme cold operations may prevent the personal contact desired by the higher commander, which means that subordinate commanders at all levels are required to take on added duties and responsibilities.

4. With regard to mental health, the following important points must be noted:

   a. Recreation is very important.

   b. Periods of both personal solitude and group relaxation are necessary.

   c. All personnel must be alert to signs of mental distress, especially withdrawal, in their organizations. When tentatively identified, it is the responsibility of all ranks to bring this to the attention of the immediate commander. It is that commander’s responsibility to act appropriately on the information.

5. Responsibility for promoting and preserving health and for preventing disease rests with commanders at all levels. Officers and non-commissioned officers (NCO) must constantly strive to improve the physical and mental health of their soldiers. Extreme cold conditions will affect leaders too. Officers and senior NCOs must constantly be on the lookout for these signs of distress among their peers as well as their soldiers.

CAPTURED PERSONS, DETAINEES AND PRISONERS OF WAR

6. Given the scarcity of resources and tenuous logistics, the custody and care of captured persons, whether prisoners of war or civilian detainees, presents significant challenges in cold weather and Arctic operations. In accordance with the laws of armed conflict, international humanitarian law and Canadian law, captured persons shall at all times be treated humanely and in a manner consistent with the treatment of our own troops. Therefore, commanders must completely understand not only their authority to take captured persons but also their responsibilities for their care and well-being. Because captured persons represent a significant logistical burden, they should be evacuated from forward areas to more established rear locations as soon as practicable. Capturing forces are responsible for ensuring that captured persons are at all times appropriately clothed, protected from extreme cold and the elements and cared for to the same standard as themselves. Where possible, the Canadian Forces should make use of existing civilian infrastructure. Civilian detainees captured by the Canadian Forces must be handed over to civilian authorities as soon as possible. The handover of civilian detainees to civilian authorities shall be accompanied by grounds for capture, including witness statements and all evidence gathered at the scene or on their persons. Commanders must keep in mind that captured persons constitute a significant security risk and as such must be kept isolated from sensitive activities and under appropriate guard. Guards must be in possession of and trained on duly authorized rules of engagement (ROE). Lastly, although in Arctic operations it is unlikely that large numbers of people will be captured, the sensitivities and risks associated with capturing and holding prisoners or war and civilian detainees require commanders at all levels to consider captured persons in operational planning, make appropriate contingency plans and make maximum use of specialist Military Police and personnel for handling.

BURIAL

7. Canadian and allied dead will ultimately be evacuated from any operational area for burial in their home regions. This must be anticipated and the necessary steps put in place prior to the operation. It is possible that due to the tempo of operations, it may be necessary to temporarily place casualties in temporary morgues, or even temporary gravesites, and this must also be anticipated.

8. Adversary dead must be treated according to the Geneva Convention. They will likely be placed in temporary burials and, upon conclusion of hostilities, returned to their home nation’s control.

GARBAGE AND SALVAGE

9. The high permafrost and the cold weather make burying garbage almost impossible. Also, given the cold, garbage does not decompose as it does in more temperate regions. In areas of extreme cold, like the Canadian Arctic, garbage dumps dating back many decades may show virtually no deterioration. To protect the environment, garbage will be collected in cold weather operations, and certainly in the Canadian Arctic. When transport is available, garbage must be moved south, by aircraft if necessary, for proper disposal. During high-intensity, large-scale operations this may not be possible until the conclusion of hostilities, and large amounts of garbage may have to be stored in temporary dumps until it can be dealt with. Ultimately, it is the responsibility of the CF to return the land used for dumps to its original state.

10. Salvage consists of abandoned or slightly damaged clothing, equipment and vehicles, including those of the enemy. Recovery and reuse of salvage is important, as recovering and repairing equipment is far less taxing to the transport system than replacing it.

PERSONAL DEMAND SUPPLIES

11. There are two main considerations around the provision of personal demand supplies. First, there are usually no local suppliers in many of the cold regions of the world, so there is often no option to the CSS system for providing sundries and small luxury items. Second, and possibly more important, where these items (snack foods, papers, books, personal items, etc) exist, few local communities will have sufficient stocks of these things to allow significant purchase by the military. If such purchases are allowed at all, the military will likely have to replace the purchased stocks in order to allow the local supplier to meet the needs of the local population. This is because the normal civilian suppliers may be unable to provide replacement stock on the required scale within a reasonable timeframe. It must also be noted that transport space will always be at a premium on northern operations, and supplies of this nature will be limited and may have to be rationed to ensure fair distribution.

CHAPTER 10
COMMUNICATIONS IN THE CANADIAN ARCTIC

SECTION 1
INTRODUCTION

GENERAL

1. Military operations in regions of extreme cold, including the Canadian North, are typically characterized by the employment of forces beyond the range of mutual support, and at considerable distances from controlling headquarters and administrative bases. Due to this dispersion, much greater use must be made of radio at longer ranges than in more conventional operations. G6 staff must be consulted early in the planning stages to ensure that appropriate communications can be maintained. For example, the use of satellites and microwaves for long-range communications is rapidly changing the way military communications are conducted. This is particularly true in far northern regions around the globe, where conventional communications networks are less well developed, and where satellite systems may not work particularly well due to the high latitudes.

2. Despite a general lack of infrastructure in the Canadian North, one of the more highly developed aspects is the communications systems. These systems are extremely vulnerable and must be protected from any adversary action. Communications systems of the adversary are also vulnerable. Communication liaison with other agencies will greatly enhance operating systems.

3. Aircraft, UAVs and helicopters can assist in overcoming communication difficulties caused by terrain and extreme climatic conditions by acting as airborne relays and providing air dispatch service. Another possibility for providing an element of airborne comms relays is tethered balloons.

ENVIRONMENTAL PROBLEMS

4. High-frequency (HF) transmission and reception, while capable of spanning the extended distances dictated by tactical requirements, is subject to interference by magnetic storms, the aurora borealis and ionosphere disturbances, which may completely black out reception for hours or even days. However, transmission and reception under most conditions is possible providing that proper installation and operating procedures are followed.

5. The combined effect of terrain, cold, ice, dampness and dust on communication equipment increases maintenance and supply problems to the extent that the utmost effort of operators and repair personnel is required to provide satisfactory communications.

SECTION 2
RADIO COMMUNICATIONS

PROPAGATION CHARACTERISTICS

1. Radio communication in northern latitudes suffers from propagation difficulties, and exceptional planning steps are essential. Emphasis must be placed on the selection and use of proper frequencies. Use should be made of radio propagation graphs, charts, and prediction data for this purpose. Channel evaluation techniques should be used on northern high frequency (HF) circuits to the extent that equipment makes this possible. Even when sophisticated sounding equipment is not available, simultaneous transmissions on several frequencies (similar to “fleet broadcast”) from a base station provide quite an effective means for out stations and mobiles to select the best frequency.

2. The transmission of a radio signal from a transmitter and receiver can occur essentially in one of two ways: by a direct path between the antennae of the transmitter and receiver, called the ground wave, or by reflection from a layer in the upper atmosphere or ionosphere, called the sky wave. Since the reflective power of the ionosphere varies with the frequency and the time of day, there are limitations imposed on the frequencies that can be used. At higher frequencies (over 40 MHz) most of the energy in radio waves passes through the ionosphere and is not reflected.

3. Tactical radio equipment operating in the so-called line-of-sight band (30 MHz and upwards, which includes the frequency-modulated (FM) series of tactical radio sets) is not adversely affected by aurora activity, except as noted in this paragraph. In fact, the greater ionization in the upper atmosphere which takes place during auroral activity will on occasion increase the range of tactical FM sets. The use of very high-frequency (VHF) and microwave radio relay equipment will provide the best means of short-range communications, especially amplitude-modulated (AM) voice.

AURORAL EFFECT

4. The reflecting properties of the ionosphere are directly related to the density and uniformity of the earth’s magnetic field, which in turn is affected by the position and radiation activity of the sun. As far as radio communications are concerned, sky wave is subject to greatly increased absorption and diffusion which results in fading, distortion and short-term blackout of the received signal during periods of intense auroral activity. The greatest auroral activity takes place between 60 degrees and 70 degrees north latitude, and occurs at intervals of 27 to 28 days. The highest variations are experienced in fall and winter. Although all frequencies up to HF are affected, they are not all affected to the same degree.

IONOSPHERIC DISTURBANCE

5. The effects of solar storms and disturbances on the ionosphere are worldwide; however, in Arctic areas those effects tend to be very severe and are felt almost instantaneously with the occurrence of solar storms. One type of disturbance called polar cap absorption, which is caused by solar flare activity, can result in a complete blackout on sky wave and scatter systems for periods of several hours, and on HF during severe disturbances for several days. The effect of these storms can be greatly magnified when they coincide with periods of maximum auroral activity. For polar areas, these disturbed conditions can be predicted only in general terms.

ATMOSPHERIC STATIC

6. Continuous high-level static is rarely experienced in Arctic latitudes, but sporadic noise is common. This can also occur in any region of extreme cold with high winds and dry snow. Irregularly occurring and steady rushes of increasing noise frequently signify auroral disturbances on the frequency employed. Generally low frequency (LF) is less affected by this type of atmospheric noise than HF. Another source of noise is precipitation static. Flakes or pellets of highly charged snow are occasionally experienced in northern regions during periods of high winds. Charged particles of snow, when driven against metal vehicles, masts and antennae, discharge with a high-pitched static sound that can be heard on all frequencies. This form of noise is more often encountered on aircraft radio and vehicle-mounted stations than on ground stations.

ANTENNAE AND GROUNDS

7. Difficulties will be experienced when erecting antennae in conditions of extreme cold. The frozen ground makes it difficult to drive the antennae ground and guy pegs and the ground plate rods into the ground. Care must be taken in handling lead-in and metal mounts, since they become brittle in the cold. Vertical antennae are preferred for ground wave propagation in the HF band, but the use of fractional wave-length whip antennae is not recommended except for short distances. Antenna towers can be easily installed on lake or sea ice by means of toggles deployed through holes drilled in the ice for guy anchors. The underlying fresh water or sea water provides a predictable electrical ground.

8. All large horizontal antennae should be equipped with counterweights arranged so as to give before the wire or poles break from the pressure of ice or wind. Wet snow and sleet that freezes to the antennae may be removed by jarring the supports.

9. Ground conductivity in northern areas is generally low, with ice cap, permafrost and snow-covered terrain ranking among the poorest anywhere. At HF and below, effective ground-wave ranges are considerably reduced over this type of ground. Great care must be taken in siting to secure the best available ground, and considerable effort may be needed to build an artificial system. In no instance should more than one transmitter be connected to one ground or counterpoise, nor should electrical noise-producing items such as direct current (DC) battery-charging generators or metal-walled huts be connected to a receiver ground system.

10. Very heavy shocks can be experienced from the ground lead in antennae subject to high winds or blowing snow, even when the degree of audible static is not great.

11. The use of ground-plane antennae and dipoles for tactical radio must be considered in every operational plan. Telescopic-type ground-plane antennae masts will increase the range of the tactical radio sets. In the Arctic it is essential to position the antenna at a minimum of 6 metres above ground level to counter the effects of the highly charged particles of blowing snow. Command vehicles mounted with tactical radio sets should be equipped with facilities to use either a ground-plane antenna or a dipole antenna mounted on an elevated mast or tower.

12. The normal working range for a vehicle-mounted tactical radio set is 30 to 40 km.

BATTERIES AND POWER SUPPLIES

13. Although extreme cold affects all electrical and electronic components, it has its most serious effect on batteries.

a. **Dry Batteries.** The conventional dry cell loses efficiency rapidly at low temperature and decreases in capacity as the temperature drops below 21 degrees Celsius. The terminal voltage is not affected by cold, but the life capacity is lowered, and the ability to supply a given voltage over a period of time falls off drastically at temperatures below -18 degrees Celsius. However, the capacity of a dry cell may be restored by warming it to the operating temperature. Battery warmers are provided to restore cell capacity, and insulated containers are provided to reduce heat loss during operations. Special cold-weather batteries are now available which permit a much longer lifespan in temperatures down to -40 degrees Celsius. Battery packs for fixed installations such as beacons, radio-controlled runway lights or detection systems can be placed in or below lake-ice or sea-ice cover or even buried in snow to provide a constant temperature environment (0 degree Celsius to -1.7 degrees Celsius).

b. **Storage Batteries.** The efficiency of storage batteries varies widely by type. Nickel cadmium batteries have the least variation through the lower temperature ranges and are therefore a preferred power source. Batteries of the lead-acid type are less effective at low temperatures because their ability to deliver a rated voltage falls off very rapidly with use. Under these conditions batteries must be kept fully charged at all times, as they are liable to freeze. When radios are powered by vehicle electrical systems, great care must be taken to ensure that prolonged or excessive loads do not reduce the potential below that needed to operate the radio or crank the engine. Lithium batteries are effective down to -40 degrees Celsius but will not hold their charge long unless kept in inner pockets or insulated battery packs.

c. Cold temperatures dramatically reduce the effectiveness of chemical reactions within the battery, while increasing the battery’s internal resistance. Both of these changes cause a reduction in cranking power as temperatures drop. Batteries left in a discharged state are also susceptible to freezing, which damages internal components and containers. Batteries are best stored at temperatures between -12 degrees Celsius and 2 degrees Celsius.

TACTICAL NETS

14. Command radio nets must be established first, and priority must be given to their maintenance throughout the tactical operation. When a unit moves out of ground range of its base of operation, rebroadcast or relay stations must be established, or sky wave propagation will have to be depended upon. When it can be anticipated that distances are so long as to preclude communications with equipment normally available, higher headquarters should be requested to furnish communication support. Situations may arise where communications will not meet expectations. Alternative means such as messenger services must always be included in the signal plan.

15. The effects of the environment, including the conditions of the atmosphere, will affect the radio net at all levels. Loss of contact drills must be initiated and closely followed.

16. The establishment of air-ground nets is of major importance in all tactical operations in high northern latitudes because of the great dependence on aircraft to support all operations, including airborne, airmobile, reconnaissance, and logistics operations.

17. The use of mobile VHF and UHF radio relay equipment will provide the most reliable means of communication to mobile task forces at the unit level. This equipment will require the same mobility and protection as their supported units.

SECTION 3
ELECTRONIC WARFARE (EW)

GENERAL

1. The low temperatures, low visibility, and the lack of land lines in the northern region impose greater reliance upon wireless communication systems for command and control of land forces. Radio navigation aids, so necessary because of the scarcity of landmarks, high-latitude issues inherent to GPS, prevailing low-visibility and the long hours of darkness, are particularly sensitive to EW/Signals Intelligence (SIGINT) capabilities. This is especially true when alternative base stations are few and far between. Further, the lack of satellite communications in the High Arctic will necessitate the use of line-of-sight systems and/or omnidirectional systems that bring with them an inherent susceptibility to intercept and direction finding by adversary elements.

2. On the other hand, the enemy must also rely on electronic aids. A small EW/SIGINT unit, properly employed and equipped, can play a significant role in northern operations through the timely intercept, direction finding, and the use of EA to support any use of joint fire. These units must be integrated into the manoeuvre element wherever possible to provide timely support but still retain the flexibility to mass in order to give the commander useful combat information and intelligence.

3. EW/SIGINT operators must be highly proficient and be able to operate specialized equipment in adverse conditions. Additional training and experience may be necessary to allow them to recognize the difference between atmospheric interference and hostile electronic attack (EA).

SECTION 4
LINE COMMUNICATIONS

GENERAL

1. Due to the distances and difficulties in cross-country northern movement, major trunk lines are rarely installed. When line is employed under conditions of deep snow or at low temperatures, much longer times are required to install circuits and to restore them in case of damage or failure.

LAYING LINE

2. Line may be laid from an oversnow vehicle or sled, or on foot.

3. Line which is expected to be used for a period of time should be “treed” or poled if facilities are available, because line laid on the surface will quickly be buried in snow. Once buried under snow, recovery and servicing of the line is extremely difficult and even more time-consuming.

4. Routes for cable must be carefully selected as follows:

   a. Ground cable is subject to damage from heavy tracked vehicles and is a hazard to personnel on oversnow vehicles or on foot. Whenever possible, separate line routes should be established away from vehicles or dismounted routes;

   b. Cable laid over frozen lakes or swamps tends to sink and become frozen in position. When immersed, it is subject to shearing from ice movement caused by thermal contraction. Therefore, cable routes should skirt bodies of water.

   c. Routes for which line is to be laid must be chosen primarily to gain reliability. In general, it is more effective to select a longer route where cable is less prone to damage than a shorter one where damage is more likely.

   d. Due to the difficulty of obtaining grounds and to the high resistance of the soil, circuits which utilize a ground return should not be used.

SECTION 5
VISUAL COMMUNICATION

GENERAL

1. Visual means are particularly effective for air-to-ground communication when atmospheric conditions or security requirements preclude the use of radio, or in mountainous country where terrain presents the opportunity for optical signalling.

2. Methods and techniques for visual signalling include flares, mirrors, air panels, lights, words cut in the snow, etc. However, visual means are also susceptible to the following constraints:

   a. During the long periods of darkness, visual signalling is restricted to illuminated devices.

   b. Blowing snow, haze, ice fog, etc reduce visibility.

   c. Air recognition panels are highly visual in daylight but can easily be covered by drifting snow. They can be mounted above blowing or drifting snow to partially overcome this.

   d. During the long periods of darkness, some kind of lights can be used. Again, however, care must be taken to ensure that they do not become covered by blowing or drifting snow.

   e. The colours of smoke most easily seen against a snowy background are, in descending order, red, violet, green and yellow. Smoke grenades and pots may have to be attached to a pole or stick or a piece of wood or cardboard to keep them from sinking in the snow.

SECTION 6
HAND CARRIAGE

GENERAL

1. Hand carriage service may have to be scheduled between formations, units and even sub-units. Although time-consuming, it may be the only reliable means of passing information at times. Well-rehearsed drills will speed the process. Regular supply runs can often be used for this purpose.

AIR

2. The use of helicopters for hand carriage may be necessary for isolated units and sub-units.

VEHICLES

3. Vehicles, particularly oversnow vehicles, may be necessary for hand carriage. Surface travel will be slow and exposed to the hazards of changing conditions. All personnel engaged in this duty must be well versed in northern navigation. Personnel must operate in pairs and carry radio equipment, survival gear, extra fuel and rations. Individuals must sign in and out when performing this duty. Estimated time requirements should be worked out, so that any failure to arrive by the expected time will be noticed.

SECTION 7
SATELLITE COMMUNICATIONS AND GPS

GENERAL

1. Space systems will play a significant role in operations in the Canadian North. The small populations and vast distances make more conventional systems impossibly expensive. GPS and satellite comms will be extremely important for accurate navigation and timely communications.

SATELLITE COMMUNICATIONS

2. Satellite communications have become very common in the Canadian High Arctic, where virtually every Arctic community has access to the Internet delivered by satellite feed. Education and health services can be delivered, business can be conducted with distant partners, and communications throughout the north can be conducted in real time.

GPS

3. GPS has greatly simplified navigation in the Far North. They are also extremely useful in more southern latitudes, where heavy snowfall can obscure terrain features and make conventional map reading somewhat problematic. While the high-latitude satellite constellation is not ideal, GPS does work well at very high latitudes (the systems are consistently accurate to 80 degrees north latitude or even higher). However, GPS is extremely easy to jam. Thought and training time must be devoted to alternative navigation techniques if there is a threat of jamming.

SATELLITE CONNECTIVITY

4. Most telecommunications satellites are in geosynchronous orbits, roughly around the equator. As a result, they are hard to connect to from very high latitudes, as they appear very close to the horizon. Satellite communications systems should be set up as high as possible on hills or mountains to improve connectivity to the satellites. Ground repeater stations may have to be used in extreme northern latitudes to enable the signal to be transferred north from a more southerly station that can receive it. Often for remote areas and when dealing with over-the-horizon issues, a combination of microwave and satellite link is used to provide conductivity. This will introduce signal latency and can create timing issues for connection.

SATELLITE SURVEILLANCE

5. The Canadian Far North is vast, and it is virtually impossible to use conventional surveillance assets to maintain watch everywhere, all the time, because the necessary resources are simply unaffordable. Space surveillance systems such as the Polar Epsilon Project will allow constant surveillance to be maintained. The Polar Epsilon Project provides persistent all-weather, day/night surveillance using RADARSAT 2. It is capable of image resolution to 10 metres and less. This initial detection will cue other assets (LRP or UAV, for example) to investigate specific contacts more closely, rather than attempting to provide continuous coverage with limited platforms.

SECTION 8
UNUSUAL OPERATING PROCEDURES

GENERAL

1. Standard types of communication equipment can be used at very low temperatures with satisfactory results if precautions are taken and the equipment is properly winterized. Provision must be made in the operational plan to include the special maintenance requirements necessitated by operations in extreme cold. As a general rule, communications equipment should be installed and operated in warm shelters. Warm shelters are absolutely essential for maintenance personnel. The general principle of keeping equipment warm and dry and following winterization instructions closely will ensure the best possible performance of communication equipment.

MECHANICAL MALFUNCTIONS

2. There are three main causes of mechanical malfunction in communication equipment in extreme cold conditions:

a. **Contraction.** The various metals in a piece of equipment contract at different rates as the temperature falls. Plugs, keys, jacks, valves, bearings and dials are subject to different rates of contraction. This can cause gaps or over-tight fits within the equipment.

b. **Lubrication.** Normal lubricants and oils become so viscous at very low temperatures that they may not furnish adequate lubrication between moving parts. Special lubricants and servicing routines are needed to overcome this problem. Older equipment with dial mechanisms employing fibre gears requires specific attention.

c. **Freezing.** In addition to the trouble caused by differential contraction, moisture condensation which freezes in such assemblies will also render them inoperative. Condensation caused by localized heating may freeze subassemblies during shutdown periods and render them difficult to restart.

RADIOS

3. When receivers and transmitters adjusted for operations in a relatively warm area are exposed to extreme cold, they may exhibit, in their frequency-determining circuits, changes of sufficient magnitude to impair their operation. Low battery voltage will also have a detrimental effect. All radio operators must be trained to make frequent checks for proper frequency setting if the equipment allows.

MICROPHONE ASSEMBLIES

4. Moisture from breath can freeze on presser switches and perforated cover plates of microphones, rendering the equipment inoperative. Microphone covers must be employed, but as an expedient, the microphone can be carried inside the parka close to the body. Thin plastic or rubber sheets make excellent covers.

BREATHING AND SWEATING OF EQUIPMENT

5. Rapid changes in temperature result in malfunctions or failures to most electrical or electronic equipment. To counter this problem, the recommended policy is not to shut down the radio sets. Rapid changes in temperature result in breathing or sweating.

a. **Breathing.** A radio set (or any electronic device) generates heat when in operation. When the set is turned off, the air inside cools and contracts, and colder air is drawn in from the outside. When this cold air comes in sudden contact with the hot equipment, glass, plastic and ceramic parts can be cooled too rapidly and can break. Radios which are operated outside must be suitably enclosed and insulated against sudden changes in temperature.

b. **Sweating.** This occurs when cold equipment is brought into sudden contact with warm air and moisture condenses on the cold surface. When bringing radios, switchboards or test equipment into heated tents or shelters, care must be taken to avoid sudden warming. Wrapping the equipment in blankets or sleeping bags before transferring it will help prevent the formation of moisture.

RUBBER AND RUBBER-LIKE COMPOUNDS

6. Rubber and rubber-like compounds become increasingly stiff and brittle as the temperature drops. When cold, cordage should be flexed slowly and carefully in order to minimize breakage. If possible, rubber items should be warmed before flexing. Power cables and co-axial cable transmission lines should be warmed before they are laid in the cold. Frequent failure of this type of cable may be expected if it is necessary to reel it in under extreme cold conditions. Increased requirements for replacement parts and equipment must be expected. Where possible, contact of rubber items with POL should be avoided.

7. Extreme care must be taken when handling insulated wire or cable at subzero temperatures, as the insulation tends to become stiff and brittle and is liable to crack. Standard friction and rubber tapes tend to lose their adhesiveness in extreme cold. Special cold-weather-type electrical insulating tape is available and can be used without pre-warming. Splicing of field wire and cables is difficult because hands must be protected by heavy mittens and gloves, which will severely hinder handling.

COMMUNICATIONS SUPPLY ISSUES

8. More frequent breakdowns and the longer time required for repairs mean that units must hold larger pools of replacement communications equipment and spare parts. It may not be possible to move all the required stores into the operational area immediately, but they must be ready to be shipped forward immediately when needed.

SECTION 9
COMMUNICATIONS IN NORTHERN CANADIAN COMMUNITIES

GENERAL

1. Within the Arctic there are two main service providers: NorthwesTel and SSi Micro. NorthwesTel provides service in all three territories; SSi Micro serves only Nunavut and the Northwest Territories.

2. Nunavut is completely reliant upon satellite services for all of its communities. Just to the west, the Northwest Territories is a mixture of land-based services and satellite-served communities. In the Yukon, all but one of the communities are served by land-based services. Not surprisingly, the existence of land-based backbone services coincides with the existence of roads linking communities together.

3. Most government access to services on the land in NWT and Nunavut use Iridium satellite phones or temporary Ka-band satellite dish setups. Rangers and reconnaissance teams deployed by military personnel operating in the field carry ground-wave HF radio systems gear, plus Iridium phones connected by satellite. Each night, Rangers are required to set up and call in their coordinates. Setting up the HF radio takes time, but it operates at a fraction of the cost of the Iridium satellite phones, so people in the field continue to rely on HF radio gear for everyday communications in order to keep costs in check.

4. This older HF radio service covers much of the Arctic for military use, but there are a number of coverage holes. The military is considering putting in a new capital project to upgrade its HF radio system across the entire Arctic with a new digital HF radio system. Well-trained comms specialists must be included as part of any tactical manoeuvre element, regardless of the size of the element. These individuals must be experienced and well trained on the specific communications systems that will be used. Experience in far northern conditions will be of enormous value.

ISSUES

5. There is a shortage of affordable bandwidth in most Canadian Arctic communities, both in terrestrially served (microwave and fibre) and satellite-served communities. Although there may be more capacity available for purchase, very few individuals can afford to purchase what they need. Satellite-served communities face additional challenges on older networks that exacerbate the effects of satellite latency, so that many applications on these networks simply won't work.

CONCLUSION

6. This manual is designed to provide commanders and staffs with the doctrine for conducting full-spectrum operations in cold and extreme cold conditions anywhere in the world. It has obvious relevance to specific operations conducted in the Canadian Arctic and the Far North, but it is not specific to those locations and should not be mistaken for a manual on "operations in the Canadian Arctic" or "Domestic Operations."

GLOSSARY

Arctic
The region in which the average temperature in the warmest month is less than 10 degrees Celsius and the mean annual temperature is below 0 degree Celsius. That includes northern Canada, parts of Scandinavia and Russia, and most of Alaska. The Arctic is almost totally devoid of trees.

Arctic Operations
Operations that take place in high northern latitudes in Canada, although not necessarily above either the Arctic Circle (66°33′39″ north latitude) or the treeline.

Candled Ice
A condition where deep ice cones melt on a vertical plain. The surface water finds its way through the ice by melting from the surface to the bottom. The ice appears as a series of icicles or candles. This type of ice, although up to 13 centimetres (5 inches) thick, is extremely dangerous because it has no cohesive strength.

Climatic Conditions
The meteorological conditions (including temperature, precipitation and wind) that characteristically prevail in a particular region. The average weather conditions over a long period of time.

Cold Soaked
Equipment, including vehicles, is cold soaked when it has been exposed to extreme cold to the point where all heat has radiated out of it, and significant time and energy is required to raise the temperature of the equipment so that it can be operated safely.

Cold Weather Operations
Operations that occur when the temperature (including wind chill) is +8 degrees Celsius or below, regardless of the location or season.

Esker
A long, winding ridge of gravel and other sediment deposited by melt water from a glacier.

Extreme Cold Weather Operations
Operations that take place in conditions where the temperature (including wind chill) is -21 degrees Celsius or below, regardless of location or season.

Subarctic
The Subarctic may be defined as the vast area of climatic transition between the temperate regions and the Arctic. Its predominant feature is the vast coniferous forest.

Ice Fog
A type of fog consisting of fine ice crystals suspended in the air. It is generally caused by the production of water vapour by human activities such as the operation of heaters, motor vehicles and the like.

Moraine
A mass of rocks and sediment carried down and deposited by a glacier.

Riverine Operations
Operations conducted on waterways by armed watercraft for the purpose of controlling and dominating those waterways. Riverine operations can be offensive or defensive. The watercraft themselves do not have to be purpose-built; they can be improvised. Operations by armed watercraft to destroy enemy supply boats are riverine operations. Escorting of logistics watercraft by armed escorts are not riverine operations.

Weather Conditions
The state of the atmosphere at a given time and place with respect to variables such as temperature, moisture, wind velocity and barometric pressure.